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AN OPPORTUNITY FOR AMERICAN ENGINEERS and investors is offered by the Government of New South Wales, which advertises for proposals for the manufacture and supply of 150,000 tons of steel rails, and the track fastenings to be used with them. All the material must be manufactured in New South Wales, and the delivery is to extend over a period of ten years. The proposals will be opened on Dec. 30, 1896. It is to be hoped that some American tenders may be submitted in this competition. Further particulars are given in another column and the specifications by which bidders will be governed can be seen at this office.

PRICES OF M. C. B. COUPLERS are asked for by the Secretary of the Master Car Builders' Association, Mr. John W. Cloud, who is sending the following circular letter to M. C. B. coupler makers:

Section 13, of Rule 5, of the revised code of Rules of Interchange, which goes into effect on Sept. 1, 1896, provides that "M. C. B. couplers, or parts of same, shall be charged at manufacturer's current market prices, or replacement prices, which are to be quoted by the Secretary Sept. 1, and March 1, of each year. When the coupler manufacturers do not quote a replacement price, and do not require the return of the scrap for the price quoted, the credits for scrap shall be allowed at the rates given in the above list."

Under these revised rules of interchange, all car owners are chargeable with the repairs to their cars when away from home necessitated by ordinary wear and tear from fair service. Will you kindly quote, sometime prior to Aug. 20, the figures which I should publish to the members, as the current market prices, or replacement prices, for your coupler and parts thereof. John W. Cloud, Secy., M. C. B. Association, Rookery Building, Chicago, Aug. 3, 1896.

PLANS FOR TRACK ELEVATION on the Erie R. R. in Jersey City are reported completed and ready for the approval of the city authorities. The present station will not be changed, but the tracks will rise from the station and cross Henderson St. at an elevation of 13 ft. above their present level. From this point the tracks will run on a steel viaduct to Monmouth St., where the descent to the tunnel will begin. The estimated cost of the work is $1,000,000.

A GRADE CROSSING BATTLE took place at Bradford, Pa., on July 28, between the Western New York & Pennsylvania R. R. and the Bradford Electric Street Ry. Co., the former company trying to prevent the latter from laying a crossing over its tracks. In view of the constant dangers attending such grade crossings, managers of steam railway companies cannot be blamed for opposing them by every means in their power; but the only really effectual fighting is that done in the courts. The battle with employees at the crossing invariably does harm and seldom or never amounts to anything in preventing for any length of time the making of the crossing.

THE BOYNTON BICYCLE RAILWAY at East Patchogue, Long Island, was sold by a court officer on July 30 to satisfy a judgment against the owners. The road is 1½ miles in length and was built to exhibit the bicycle railroad system. It was bid in for $3,310 by W. H. Boynton.

THE MOST SERIOUS RAILWAY ACCIDENT of the week, and the most serious that has occurred in the United States for eight years, or since the rear collision at Mud Run, on the Lehigh Valley R. R. in 1888, was a collision at a grade crossing of the Philadelphia & Atlantic City and West Jersey railways, near Atlantic City, N. J., at 6.50 p. m., July 30. The disaster was due to the engineman of a fast express train failing to apply the brakes soon enough to stop his train before reaching the crossing. The list of casualties is 46 killed and about 60 injured, according to the best information attainable. The circumstances of the accident are described at length in our editorial columns.

A RAILWAY WRECK was caused on the Illinois Central Ry., Aug. 1, near Clinton, Ill., by failure to obey orders. Two passenger trains collided head on. Two persons were killed and seven injured. On Aug. 4, near Shamokin, Pa., a fast freight on the Philadelphia & Reading R. R. was derailed by a freight car door which had dropped on the track. A car loaded with powder exploded and set fire to the train. Two persons were killed and one injured.

A RAILWAY BRIDGE FAILED on the Vandalia Ry. near Crawfordsville, Ind., July 29. Fearing that the bridge was unsafe a locomotive was run across ahead of a passenger train to test the bridge. The locomotive was running at about 30 miles an hour and when near the center of the bridge it collapsed. Three of the five men who were on the engine were killed.

A HEAVY STORM occurred throughout Ohio and Indiana on July 29. At many places buildings were blown down or washed away by high water. A number of people are reported as killed and injured at various places.

THE EXPLOSION OF A POWDER MAGAZINE occurred at Funfkirchen, Hungary, on July 30. Five persons were killed and about 100 injured.

AN EMPTY STILL EXPLODED in an oil refinery at Jersey City, July 31, seriously injuring five men. A workman was inspecting the interior of the still while another held an incandescent lamp through the manhole. The lamp swung against a piece of iron, the glass was broken, and the glowing carbon ignited the mixture of gas and air in the still.

THE STRIKE AT CLEVELAND by the employees of the Brown Hoisting & Conveying Machine Co. has been resumed. On July 31 the company issued a letter to the press stating that the strike had been settled on the terms offered by the company the day after the commencement of the strike. These terms had been agreed to by the attorney for the strikers, who were ordered back to work. When the men applied for reinstatement the Brown company asked each individual if he understood the terms of the agreement, which stated in particular that all contracts by the company would be with individuals and not with the union. This brought on the strike anew and there is said to be danger that all union men in the city will quit work.

THE SEPARATION OF ASHES, GARBAGE and rubbish and the placing of it in three separate receptacles, was inaugurated in New York city, Aug. 1. The garbage will be treated by the Arnold utilization process, under the contract recently awarded. It is expected that the ashes will be used for filling purposes. Bids are now invited for the privilege of sorting the rubbish.

A 66-IN. RIVETED STEEL WATER MAIN, about 15 miles long, will be laid for the city of Brooklyn, as an extension to its present water supply system on Long Island. Bids for this extension were received on June 11, and were published in our Construction News Supplement for June 18. The successful contractor is Mr. John McNamee, of Brooklyn. From the reports at hand it appears that asphalt will be used to coat the pipe.

THE PASSAIC VALLEY SEWAGE COMMISSION, appointed a few weeks ago to report on a plan for preventing the pollution of the Passaic River, has held a number of meetings in the various municipalities interested and taken a trip to New England to visit sewage disposal plants. A few days ago it appointed Mr. A. Fteley, M. Am. Soc. C. E., as Consulting Engineer, and Mr. Chas. E. A. Jacobsen, formerly engineer of the Newark water department, as engineer to the commission.

PLANS TO PREVENT THE FURTHER POLLUTION of the Elizabeth River at Elizabeth, N. J., have been prepared by Mr. Francis Collingwood, late Secretary Am. Soc. C. E. The plan is said to include an intercepting sewer some three miles long, 2½ × 3¾ ft. at its upper and 5½ ft. in diameter at its lower end, with a pumping station about one-half mile from the lower terminus.

BIDS FOR A NEW WATER SUPPLY for Jersey City will be received on Aug. 24. Bids are invited for a gravity supply on three different plans and for a filtered supply from the Passaic River, the present source. The plans for a gravity supply call for water delivered at 127 ft. and at 210 ft. above mean high tide, and for at least one-third of the supply delivered at 210, and the balance at 127 ft. The system must have a daily capacity of 35,000,000 gallons, and be increased, on order, to 50,000,000 gallons. The city will have the option to buy the works at intervals during the contract. The filtered supply must be of 35,000,000 gallons capacity and must be lifted to existing reservoirs with triple expansion, high-duty, condensing engines capable of working against 140 lbs. pressure. A boiler plant must be provided and a conduit to the city reservoirs. The character of the filter plant is not restricted further than that it must yield the requisite amount of water with no more than a trace of nitrites, and that the water must be transparent and free from color, odor, turbidity, alkaline or acid tastes. The contractor must agree, further, that the filtered water shall conform to a standard of purity laid down by him, which must state its contents, organic matter, free and albuminoid ammonia, nitrates and bacteria.

THE PROPOSED INTERNATIONAL DAM across the Rio Grande at El Paso, Tex., is still under discussion. In the July number of the "Irrigation Age," a journal published at Chicago, a brief article reviews the history of the scheme, and sets forth its present status. In 1888, 1889 and 1894, the article states, the river was dry for a considerable period, while since June 1 of this year there has been no flow. The seasons named, or some of them, are said to have been exceptionally dry, and no statement is made regarding the usual dry weather flow of the stream. It is said that the Mexican government has formulated a claim against the United States for $22,000,000 damages on account of the loss of crops during the past ten years through diversion of the waters of the stream above the boundary line. It is also stated that Mexico will waive these claims if the United States will dam the river and give Mexico half the surplus water stored. A dam site has been proposed about two miles above El Paso, where it is said a structure 60 ft. high and 500 ft. long would form a reservoir 15 miles long with a storage capacity of 4,000,000,000 cu. ft., sufficient to irrigate 100,000 acres on each side of the river, also giving a large amount of power. Since this plan was formed it is said that a scheme has been put under way to irrigate from another reservoir the very lands that would be submerged by the international dam.

THE PROPOSED WATER POWER FRANCHISE at Sault. Ste. Marie, Mich., noted in our issue of July 30, has been passed unanimously by the city council. Work must be started within six months. It is said that a large amount of power will be developed, and that Mr. E. V. Douglass, of Philadelphia, is president, and Mr. F. H. Clergue, of New York, is vice-president, of the Lake Superior Power Co., which will carry out the provisions of the franchise.

THE PLANS FOR RAISING THE STEAMSHIP "AILSA" are almost completed. It is proposed to raise the vessel by means of large barrel shaped wooden cylinders, 30 ft. long and 8 ft. in diameter. The cylinders will be filled with water and submerged so that they can be fastened by chains beneath the hull. Compressed air will then be forced into the cylinders. Twenty-four cylinders will be employed. The "Ailsa" was sunk on Feb. 29, 1896, by the French steamer "La Bourgogne," in the channel leading out of New York Bay. The "Ailsa" is lying in comparatively shallow water.

A TEST OF THE ADHESION OF CONCRETE TO IRON has recently been made in connection with a piece of concrete and iron construction now going on in Milwaukee, Wis. A block of concrete, 16 × 3 × 4 ins., with a 1-in. square bar of twisted iron passing lengthwise of it was heated to a red heat for about 20 mins. in a furnace, and was then plunged into a bath of cold water until it was cooled throughout. Upon removal the concrete was found to be somewhat soft and friable, but it soon became hard again. There were no signs whatever of any separation of the iron from the concrete nor was the concrete cracked along the line of the iron bar or anywhere else. The least depth of the iron from the surface of the concrete was about 1 in. It will be noticed that the construction was the well-known concrete and twisted iron construction of the Ransome & Smith Co., of Chicago, Ill.

AN AERONAUTICAL CONVENTION is to be held in Boston, Mass., in September, under the auspices of the Boston Aeronautical Society. A prize of $150 will be given for the best designed kite, and a special prize of $100 is offered by Mr. Octave Cleomite, Past-Pres. Am. Soc. C. E., for the best monograph on the kite.

THE HOLMAN FRICTION-GEARED LOCOMOTIVE is said to have attained a speed of 94.7 miles per hour on the South Jersey R. R., near Cape May, N. J., on July 28.

THE NEW STEEL ARCH OVER THE NIAGARA GORGE.

By Orrin E. Dunlap.

(With inset.)

One of the greatest bridges to be erected this year is the new steel arch to span the Niagara chasm on the site of the present railway suspension bridge now leased by the Grand Trunk Railway of Canada. The fact that a steel arch is to succeed this grand structure is remarkable in itself, for this suspension bridge was the first work of the kind in America, and was built to facilitate travel between the East and the growing West. It is a structure which, despite all the changes it has undergone in construction, has ever since the day of its completion afforded a constant service to trains, carriages and pedestrians.

It was on April 23, 1846, that the company received its American charter, and on June 9, 1846, a charter was obtained in Canada. In commencing work on the bridge the first difficulty that presented itself was to secure a means of communication from cliff to cliff, and this obstacle was overcome by a boy named Homan Walsh, who one afternoon while flying his kite allowed it to settle on the Canadian bank. This little kite string served to pull a cord across the river, which in turn was followed by a rope and later by a wire cable. On the wire cable so erected a car was operated both as a ferry and to facilitate the great work of building the bridge. This cableway, probably the first in America, was used for the first time on March 13, 1848. The basket used was designed by Judge T. G. Hulett, who is still living in Niagara Falls. This basket was made of strips of band iron varying in width from an inch to an inch and a half, fastened with rivets. As seen in Fig. 3, it is higher at the ends than in the center. There is a seat at each end, their depth being about 2 ft. The manner in which its shape was decided upon is most interesting. In December, 1847, Judge Hulett and General Ellet met at the old Eagle tavern at Niagara, and the latter had the contract for erecting the bridge. During their talk the merits of a cable and basket as an aid to the great work came up, and the service was recognized as possible. What material should the basket be made of? was the question. General Ellet favored wood; Judge Hulett, iron. Calculations showed that Judge Hulett's plan would result in an iron basket 10 pounds lighter than one of wood built according to Ellet's plan. The form of the basket was then quickly decided by Judge Hulett and General Ellet arising from the old-fashioned rocking chairs in which they sat, and, drawing them together, Judge Hulett said "There is the form of the basket."

While this aerial line of 1848 was not intended as a money-maker, it proved to be such, as the charge for transportation over and back was $1 for each person, and some days as much as $125 was taken. The basket is now in the possession of the Buffalo Historical Society.

Fig. 1.—Building Concrete Foundation for Canadian Abutment of the New Steel Arch Over the Niagara Gorge.

Years were consumed in the work of building the bridge, and it was not until March 8, 1855, that the first train crossed it. As first erected, the bridge had wood trusses and towers of stone. In 1880 the suspended structure was changed to steel, and in 1886 the stone towers were replaced by towers of steel. The present bridge has a span of 821 ft. from center to center of towers. It is suspended on four cables, the diameter of each being 10¼ ins., and their ultimate strength 12,400 tons. The weight of the superstructure is 800 tons.

Mr. L. L. Buck, M. Am. Soc. C. E., is chief engineer of the new steel arch. Mr. Buck is thoroughly familiar with the suspension bridge and its locality, for it was from his designs and under his personal supervision that the suspended structure and towers were renewed, as above mentioned. It will be recalled that this work was completed without the slightest interruption to traffic, and it has gone down in history as one of the many brilliant things accomplished by Mr. Buck.

This grand new arch will have a span of 550 ft., between the end piers, and a trussed span 115 ft. long will connect it with the top of the bluff. The main span will be formed by an arch with horizontal upper chords. At the skewbacks it will be hinged. Each truss will have a batter of 1 horizontal to 10 vertical. The width between the centers of the top chords will be 30 ft., while between the centers of the rib at the crown the width will be 56 ft. 7¾ ins. From the centers of the skewbacks to the upper chords will be 134 ft., while the centers of the ribs at the crown will be 114 ft. above the skewbacks. On the American side the bed plates of the arch will rest on masonry built on the Clinton limestone, but on the Canadian side it has been found necessary to build a foundation of concrete, work on which is illustrated in Fig. 1. On this foundation the masonry will rest. It will be seen by the illustrations that the abutments are being built about half way up the slope on each side, between the water's edge and the top of the bluff. The ends of the shore span will be hinged to the arch by a pin at the point of intersection of the end post and top chord of the arch, while the shore end will rest on expansion rollers on masonry abutments.

As stated above, the new arch will have two floors or decks. On the upper chords of the arch transverse steel beams will be placed, and between these beams there will be four longitudinal lines of steel stringers. These will be 7 ft. apart and directly under the railway tracks, thus affording double track railway facilities, whereas there is but a single track on the suspension bridge now in use. A steel plate, reaching from end to end of the bridge and from the top of the upper chords to the tops of the ties will cover the ends of the railroad ties and the transverse beams.

Fig. 3.—Basket in Which Passengers Were Carried Across the Niagara Gorge in 1848.

The ties of the railroad tracks will be 10 × 10 ins. × 10 ft., laid 14 ins. c. to c., and will rest on the stringers. Wooden guard rails 8 × 9 ins., notched over each tie, and secured by bolts, at every third tie, will be placed over the stringers and rest on the ties. Every fourth tie will be of increased length to carry a walk. These walks will be placed outside of each track and between the tracks, a feature especially provided to facilitate the customs inspectors' examination of trains crossing the structure.

The lower floor will have transverse beams and four lines of longitudinal steel stringers laid about 11 ft. apart. The inner stringers will be riveted to the webs of the beams and the inner floor to the posts. The I-beams crossing the stringers will extend beyond the trusses and provide support for the sidewalks. The floor of the lower deck of the bridge, including carriage way and trolley track, to the width of 27 ft. will be laid on 4 × 10 in. timbers and planked with 3-in. oak plank laid lengthwise of the structure. Outside of these, and a few inches above the carriage floor, will be the sidewalks of white pine plank.

The material to be used in the bridge will include 5,560,000 lbs. of steel plates and angles in the form of columns, plate girders, braces and struts;

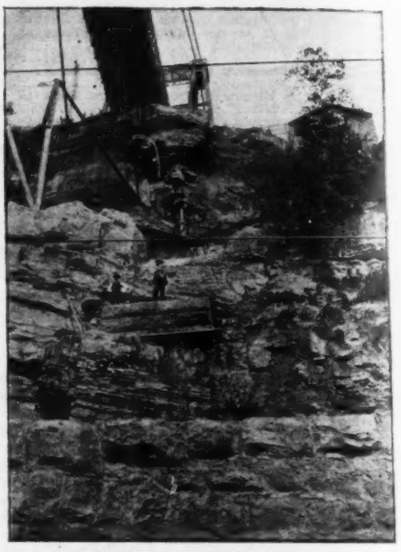


Fig. 2.—View Looking Up From the Water's Edge on the American Side.

(The masonry in the foreground is the wall behind which is the roadbed for the electric railway which now runs through the gorge.)

218,000 lbs. of steel castings; 182,143 lbs. of steel eye-bars and pins, and 30,000 lbs. of wrought iron rods and turnbuckles. The arch supports will be steel castings. The specifications provide that the steel for the rollers must have an ultimate strength of from 65,000 to 70,000 lbs. per sq. in.

The new arch is designed for a load on each track of two locomotives with four pairs of drivers each, and 40,000 lbs. on each pair, followed by a train of 3,500 lbs. per ft. In addition to this may be placed a live load of 3,000 lbs. per ft. on the lower floor.

In erecting this structure the end spans and the first panels and posts of the ends of the arch will be supported on falsework. It is then proposed to connect the end spans with the end posts of the arch, and by means of the approach girders, with the temporary anchorage, when the two parts of the arch will be built out as cantilevers. It is not intended that traffic on the suspension bridge shall stop while the work is in progress, and for this reason the upper floor beams of the arch will be left out until the suspended structure of the new bridge shall be raised sufficiently high to allow the beams to be placed under the upper chords of the suspension bridge. While this is going on, the cables and towers of the bridge may be taken down and removed. Then the old bridge will be shoved to one side far enough to allow the laying of a track on the pair of the new stringers, when the old bridge can be taken apart and the arch completed. During the construction it is likely that wire ropes of good strength and size will be run over the present towers with trolleys attached to carry material out over the gorge to the point of operation.

Mr. Thomas Reynolds is superintendent of the

bridge. The stone for the American abutment is being brought from Chaumont, Jefferson county, N. Y., and that for the Canadian abutment from Queenston, Ont., quarries, the concrete being now ready for the stone work. By means of a derrick erected on the north side of the bridge, the huge stones are lowered to the slope

Typical Sections of Main Members of Arch.

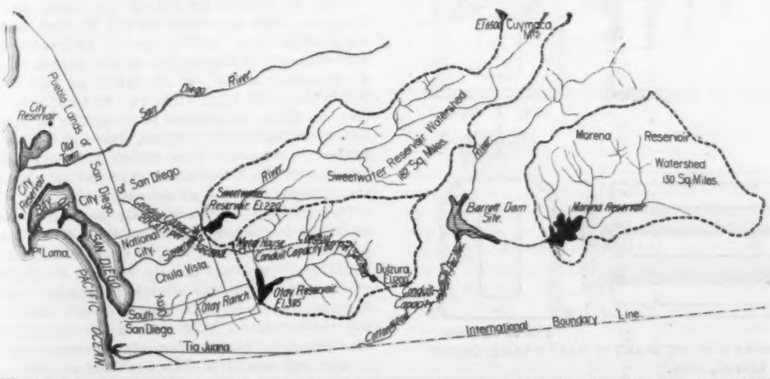
below, where they are picked up by another derrick and lowered to the abutment.

By Fig. 1 it will be seen that on the Canadian side a long trough or chute has been erected and extends from the bridge to the work on the slope. It is through this chute the sand is lowered, and at about the same point the cement is lowered in bags.

THE WATER SUPPLY FOR SAN DIEGO, CAL.

The movement for the municipal ownership of water-works has been strong in California, as elsewhere in the United States, during the past few years. The largest city in California to take decisive steps towards owning the works supplying it with water is San Diego. On June 27, 1896, by 57 votes over the required two-thirds majority, the people of San Diego voted to issue $1,500,000 of bonds for water-works. This sum is to be divided about equally between the work of developing and bringing a supply to San Diego and the work of distributing it within the city limits. The principal interest attaches to developing the supply, as this includes a rock fill dam with an asphalt face, 3,100 ft. above the sea; a storage capacity of 632,448,000 cu. ft., or 4,730,000,000 gallons, above the 30-ft. contour line of the dam; and some 50 miles of conduit, made up of natural rock channels, cement-lined canal, wood and steel pipe.

The city of San Diego had a population of 16,159 in 1890. It has been supplied with water by a private water company since 1873. In 1891 it was reported that the city had leased the private works for 20 years, but this lease seems to have been discontinued afterwards.



MAP SHOWING THE LOCATION OF THE NEW STORAGE RESERVOIR AND SUPPLY CONDUIT FOR SAN DIEGO, CAL.

The $1,500,000 of bonds noted above were voted, practically, as a ratification of and a means of carrying out a conditional contract made with the Southern California Mountain Water Co. on May 9, 1896, for building the proposed new works and supplying the necessary water rights and land.

The contract calls for a daily supply of 1,728,000 cu. ft., or 12,950,000 gallons a day. The gathering area includes about 130 sq. miles of territory east of the city and beyond the drainage area of the great Sweetwater reservoir of the San Diego Land & Town Co., as shown on the accompanying map. The Otay reservoir, also shown on the map, to the south of the Sweetwater system, is already under construction by the Southern California Mountain Water Co. Water from it will be used for irrigating low lands in the southwestern part of the tract, shown by the map. The Otay reservoir will be filled, in part, it is said, from the Morena reservoir, as the new reservoir for San Diego is to be called, a conduit leading to the Otay reservoir from Dulzura Pass, at an elevation of 1,200 ft.

The conduit from the Morena down to the Dulzura Pass is to have a capacity of 100 cu. ft. per sec.; from this point to the meter house, shown on the map, the capacity is to be 60 cu. ft. per sec., and from there to the city line, 20 cu. ft. per sec. The daily capacities for these portions in gallons are about 65,000,000, 39,000,000 and 13,000,000 gallons, respectively. The portion of the conduit between the meter house and the city is not included in the contract for developing a supply. This section of the conduit, with four reservoirs and the distributing mains, is to be under a separate contract, but the Southern California Mountain Water Co. has bound itself, when bids for this work are invited, to submit a proposal of not over $728,000.

The contract between the city and the above company contains no detailed specifications regarding the character of the dam and the conduit to the meter house, but does contain specifications for the balance of the conduit and the distribution system. The conduit from the meter house to the city will be at least 29 ins. in diameter, of wood where under less than 100 ft. head, and where under high pressure of riveted steel. One of the four distributing reservoirs will have a capacity of 5,000,000, another of 2,500,000, and two of 500,000 gallons, each.

The city is given the right to adopt whatever measuring devices it may see fit for use at the meter house. It also has the option of buying an additional quantity of water delivered at the meter house, up to a second 13,000,000 gallons, at any time within 20 years.

Mr. E. S. Babcock, Manager of the Coronado Hotel, San Diego, is president of the Southern California Mountain Water Co., and Harris & Russell are engineers. Mr. E. E. Capps is city engineer of San Diego.

THE STRENGTH OF TIMBER AND A FORMULA FOR TIMBER COLUMNS.

In our issue of Oct. 24, 1895, we printed a table of average safe working unit strains of various timbers recommended by a committee of the Association of Railway Superintendents of Bridges and Buildings, and presented at the Annual Convention of the Association at New Orleans on Oct. 15. The pamphlet copy of the proceedings of the convention, now printed, contains a large amount of interesting matter on the subject of the strength of timber, much of it being a compilation of matter previously published, but also including some new information. Among the latter is a formula for strength of columns derived by Mr. A. L. Johnson from the unpublished results of the government timber tests conducted at Washington University by Prof. J. B. Johnson, supplemented by an examination of previous full-sized column tests. Mr. Johnson also gives a table of unit stresses recommended for various kinds of timber, which is also based chiefly upon the government tests. The formula is as follows. For timber columns with square ends (but not for fixed ends):

$$f = F \times \frac{700 + 15\,c}{700 + 15\,c + c^2},$$

where

f = ultimate breaking unit crushing stress on long column.

c = ratio of length to least cross-sectional dimension.

F = ultimate breaking unit crushing stress on short column.

The recommended values for F are those given under "crushing strength endwise" in the table printed below.

Mr. Johnson considers his formula as of nearly if not the true theoretical form, and the coefficients are entirely empirical, based upon actual tests. In the table given above the unit values given are for large-size sticks, such as are used in practice. The ultimate strength across the grain is taken as the stress producing an indentation of 37% of the thickness of the compressed stick.

Recommended Values for Unit Stresses of Timber. A. L. Johnson, October, 1895. Ultimate Breaking Stresses in Pounds Per Square Inch.

Species		Modulus of strength at rupture in lbs. per sq. in.	Modulus of elasticity in lbs. per sq. in.	Relative elastic resilience in in. lbs. per cu. in.	Crushing strength endwise lbs. per sq. in.	Crushing strength across the grain lbs. per sq. in.	Tensile st'gth lbs. per sq. in.	Shearing strength parallel to fibre lbs. per. sq. in.
Long-leaf pine	D	7,750	1,440,000	1.30	5,000	645	12,000	500
Short-leaf pine	D	6,500	1,200,000	1.30	4,200	645	9,000	400
White pine	D	4,400	870,000	1.00	3,500	440	7,000	300
Norway pine		5,450	1,132,000	....	3,800	430	....	...
Colorado pine		4,900	888,000	....	3,150	540	....	...
Douglass fir		6,600	1,380,000	....	4,400	500	....	...
Redwood		7,200	452,000	....	3,250	345	....	...
Red cedar		5,000	670,000	....	3,500	750	....	...
Bald cypress	D	5,000	900,000	1.10	3,375	360	6,000	240
White oak	D	6,000	1,100,000	1.25	4,000	1,200	10,000	800

Note.—The values marked "D" were obtained from experiments made by the U. S. Forestry Division. The other values were obtained from various sources, chiefly from the tenth census report, but so modified as to give results comparable with the forestry division values.

These values are for 18% moisture, representing a half dry condition. For modifications of these values for other moisture conditions, and for fuller general description, see bulletin on "Timber Trestle Design," issued by the forestry division.

THE NEW IRON DISTRICT IN SOUTHERN RUSSIA.

In a recent number of the Consular Reports is an interesting article on the Iron Industry of Russia, translated from the "Vienna Handels-Museum." It describes the development of the industry in the department of Yekaterinosslav, in Southern Russia, where, since 1887, six large manufactories have been established. In 1893 their production amounted to 322,439 tons, in 1894 to 416,157 tons, and the production for the year 1896, it is estimated, will reach 645,000 tons, or double that of 1893. The iron beds of Southern Russia are very extensive and contain ore carrying as high as 70% of iron. The article also states that "the ore is comparatively free from foreign admixtures; on the other hand its fusibility is not great, about 45% of flux being required to melt it." About 55 lbs. of coal are required for the manufacture of each pood (36 lbs.) of cast iron. These statements about the amount of flux and of coal would indicate either that the statements concerning purity of the ore are not accurate or else that the method of operating the furnaces is uneconomical as compared with that of modern

American furnaces. The coal supply in the immediate neighborhood of the iron mines is abundant, the output in the Doneg basin in one year, 1893-4, amounting to over 5,350,000 tons. Limestone also is found in vast quantities on the spot. Under these circumstances, says the report, it is beyond doubt that the near future will see an immense development of the mining industry in Russia. At present, however, the total product falls short of the requirements, which are constantly increasing, and great quantities of cast and rolled iron are imported from Germany. The report states that there is a favorable opportunity for Austrian iron founders (and for the American founders also, says Consul Stephan), to extend their sales in Russia. The prices for iron charged by the Russian furnaces are so high that, notwithstanding the high duty on cast iron, wrought iron and steel, machine makers find it more profitable to buy imported iron. If, however, the statements given in the report as to the abundance of ore, coal and limestone in the same field, and the increase of production since 1887 are true, it would appear that before long Russia will be able to make all the iron and steel she needs for her own consumption, if in fact she does not even become an iron exporting country.

STEEL LOCK GATES FOR 800 x 100 FT. SHIP CANAL LOCK, SAULT STE. MARIE, MICH.

An illustrated description of the lock chamber, steel gates and power machinery for the new U. S. Government ship lock at St. Mary's Falls, Mich., was published in Engineering News of Sept. 26, Oct. 10, 17, 31 and Nov. 28, 1895. Since that time much additional information regarding the design and construction of the steel gates has become available and is presented here in part as a supplement to the previous articles. This matter should preferably be read in connection with the illustrations published in Engineering News of Oct. 10 and 17, but for the clearer understanding of those who have not these issues the article has been made complete in itself. For the information from which it has been prepared we are indebted to the reports of Capt. H. F. Hodges, Engineer Corps, U. S. A., and of Mr. David Molitor, United States Assistant Engineer, published in the report of the Chief of Engineers, U. S. A., for 1895, and to information received direct from Mr. J. L. Callard, United States Assistant Engineer.

Introductory. — Three sets of locks have been built at the St. Mary's Falls Canal, viz., the flight of two locks built by the State of Michigan in 1855 and now removed; the single lock built by the United States in 1881 and still in use, and the single lock which has just been completed and was built by the United States nearly on the site of the old state locks. The gates of the first locks were of wood and iron and closed an opening of 70 ft. The horizontals were constructed of solid built timber bowstring girders trussed with adjustable iron rods. Each leaf was swung without rollers from a pivot and set of suspension rods passing over a post rising from the masonry at the hollow quoins. The gates of the lock built in 1881 close a clear opening of 60 ft. Their structure is similar to that of the older gates, but the mounting is different, the fastenings being the ordinary pivot, gudgeon and collar, without suspension rods or rollers. Each leaf of the lower lock gate of this lock weighs 76 tons and cost about $8,000.

The new 800 × 100-ft. lock has five sets of gates, viz., an upper and lower guard gate and an upper, intermediate and lower lock gate. Of these the guard gates are used to isolate the lock when it is pumped out and the lock gates are used in passing vessels. The average lift of this lock is 17.61 ft., the depth of water over the sill is 22.24 ft., and the surface of the coping of the side walls is 45 ft. above the floor. It is clear, therefore, that the lower lock and intermediate gates must be of very large size.

Compared with the gates of other great locks these gates have the dimensions shown in the accompanying table. It is evident that a careful study was necessary before fixing upon the design of gates of such size.

Choice of Material.—Preliminary designs were prepared for gates of the kind now in use in the lock of 1881; for composite gates with timber arches and iron sheathing, and for metal gates with and without an air chamber. Estimates based on these designs at the prices of material ruling in 1886 to 1888 indicated that there would be but little difference in the first cost of gates of either material, the advantage lying with the timber, while it was probable that the metal structures would far outlast the others. This superior durability seemed probable from the fact that certain iron gates built in Germany more than 40 years ago are still in service and in excellent condition, while timber gates rarely last more than 25 years.

In this case also more than the usual number of objectionable features attached to the use of a roller to partially support the leaf, since the construction of trucks for such rollers would necessitate a modification of the projected filling and emptying system which was undesirable. Metal gates of the largest size may be constructed so as to carry the weight without the use of rollers, but with timber leaves of such large dimensions it is difficult to obtain the necessary rigidity of assemblage.

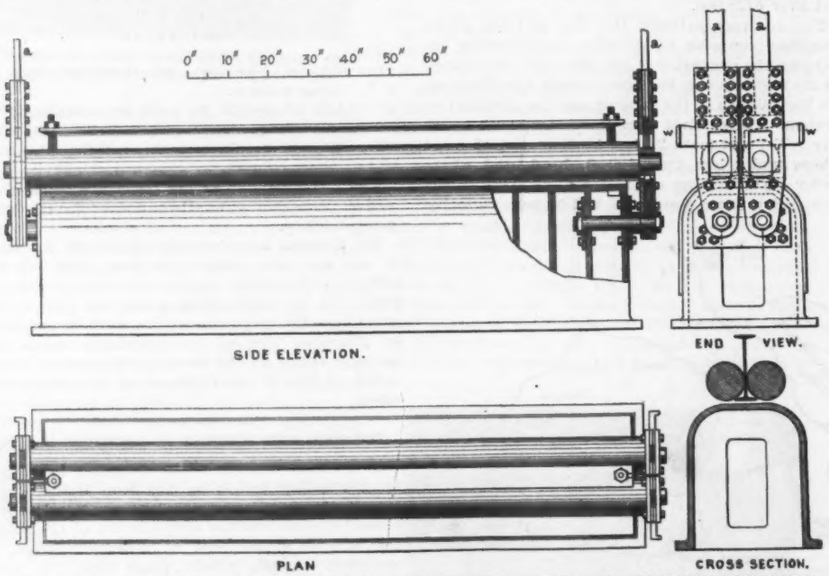


FIG. 1.—APPARATUS FOR BENDING SHEATHING OF QUOIN POSTS FOR ST. MARY'S FALLS LOCK GATES.
Detroit Bridge and Iron Works, Detroit, Mich.

Experience in France has shown that, at the present day, leaves approaching the size of those under consideration can be constructed much more cheaply of metal than wood. In the United States the cost of timber is not so great as in France, but it is continually increasing. If the gates of the new lock were to be made of wood to-day they would need to be renewed in about 20 years, when the cost of timber would probably be so great as to compel the use of metal in the reconstruction, while the shape would have to correspond to the masonry and be still designed for the original wooden structure. Thus the shorter probable life of the timber gate, the difficulty in so assemblying it as to carry its great weight rigidly without a roller, and the fear of trouble in future renewal caused the selection of mild steel as the material.

Choice of Type.—Having chosen the material the type of leaf was selected with the view of attaining the greatest lightness and facility of operation consistent with safety. When the gates are first swung or when subsquently the lock is pumped dry, the stresses due to the full weight of the leaf are thrown on its pivot and anchorage. While maneuvering, a large part of the weight may be buoyed up by an air chamber, which is easily constructed in a metal gate; but even then an accidental blow may puncture the sheathing and throw nearly the whole weight onto the pivot and anchorage. It was, therefore, considered necessary to make the latter strong enough to carry the weight in air, and on this account even more than on the score of economy of material in the gate itself, it became desirable to reduce the weight of the leaf to a minimum.

Theoretically, the water pressure on lock gates mitering can be resisted with the least amount of material in the horizontal frames when the latter are in the form of segmental circular arches extending from quoin to quoin and subtending an angle of 133° 33′ 48″, of which each leaf, of course, subtends half. When the lock is 100 ft. wide, arched gates of this curvature will support a given normal pressure with about one-half the material which would be required in the lightest straight gates which can be designed with the same factor of safety.

In practice, with leaves of the span in question, so great a curvature has two objections, viz., it increases the depth of the gate recesses and it increases the tendency of the gate to warp under its own weight when swinging without a roller. By calculation it was found that the theoretical weight of arched leaves of the same span and different rises increases slowly at first and subsequently more rapidly as the radius increases. For example, if the weight of the lighted leaf with a curvature of 66° 46′ be taken as 100, the leaf 40° will weigh 122, while the leaf 22° will weigh 200. It being recognized as desirable to make the gates as light as possible, the type with fully arched horizontals was selected, but it was not pushed to the theoretical extreme on account of the objection to the great curvature.

The number of horizontals to employ was a question requiring consideration. There seemed but two alternatives, viz., to space either the horizontals or verticals closely enough to supply the main supports to the sheathing against local hydrostatic pressure. In the one case many horizontals would be used with a vertical system of less strength; in the other the horizontal strength of the leaf would be concentrated at the top and a vertical system would be used strong enough to receive the water pressure and transmit it to the sill and the horizontal member at the top of the leaf. The large amount of pressure thrown to the sill and the localization of the thrust against the masonry at the top of the hollow quoin are objections to the latter method when the actual load on the leaf is so great and therefore the former method was chosen.

For uniformity and simplicity of construction the same form was adopted for all the gates, although the selection was originally governed by the great dimensions of the largest ones. The intermediate gate, 43 ft. high, is a duplicate of the lower lock gate. The upper lock and upper guard gates are 26½ ft. high and are duplicates,

and the lower guard gate is the smallest, being 25½ ft. high.

Construction.—In Engineering News, Oct. 10 and 17, 1895, quite full drawings of the south leaf of the lower lock gate were published and may be referred to for information in addition to what is given here. This gate is designed to bear the pressure due to 21 ft. of water, and the maximum allowable stress adopted is 9,000 lbs. per sq. in., except in those parts which are most strained by the weight of the leaf, where the fiber stress exceeds this by 1,000 lbs per sq. in., when the leaf is in air.

Briefly described, the leaf is a steel structure having a framework sheathed on both sides with plates. It is curved in plain, the two leaves forming a continuous arch when closed. The upstream and downstream surfaces are portions of cylinders. The clear distance between the sheathing plates is 30 ins. at the ends and 36 ins. at the middle, this splay being given to make the interior more accessible and to allow for variations in the position of the curve of pressure. The body of the leaf is 43 ft. high surmounted by a footbridge 20 ins. high, the top of which is level with the coping of the side walls. The chord of the leaf measured between the centers of the surfaces of contact at the quoin and miter posts is 50 ft. 7.69 ins. The median circle measured between the same, a radius of 77 ft. 3.38 ins., and subtends an angle of 42° 39′ 40″. With the adopted construction the depth of the gate recess from the inmost element to the plane of the face of the lock wall is 8 ft. 7.13 ins. The weight of each leaf in air is 312,000 lbs.

The framework of the leaf consists of 18 horizontal arches, the quoin and miter posts, seven vertical frames and a large number of intercostal stiffeners to strengthen the sheathing. The horizontal arches are uniformly spaced in a vertical direction 30 ins. apart, between centers, and are numbered from 1 to 18, beginning at the top. The space between arches 8 and 18 constitutes the air chamber which buoys up the leaf so that its weight in operation will be about 60,000 lbs.

The quoin post is made of ⅜-in. plates so curved in plan that the bearing of the post against the masonry is a plane surface 10 ins. wide. This plane is tangent to two cylindrical surfaces which round off the corners. There is no contact between the post and the hollow quoin until the leaf is completely closed. An oak cushion secures a water-tight joint when contact is secured. At the top of the post is a detachable gudgeon of forged high carbon steel 8 ins. in diameter, and at the bottom is a foot plate of like material having in its bottom a socket bushed with bronze. This socket fits onto a spherical pivot 10 ins. in diameter keyed into a circular bed plate of cast steel set in the lock floor.

The miter post is formed by bending the sheathing around the ends of the horizontal arches. Each holds by means of angles an oak cushion which forms the contact surface 12 ins. wide.

Between the quoin and the miter posts come the vertical frames. These consist of three full frames extending from top to bottom of the leaf and spaced at equal distances horizontally. These full frames divide the leaf into four water-tight bulkheads, each of which is provided with a pump. Between the full frames are four half frames which extend from the top to the bottom of the air chamber only and support its sides against the water pressure. To support the sheathing against local water pressure the intercostal stiffeners are used. These consist of angles extending vertically between the horizontal arches, and spaced to suit the pressure.

The sheathing is attached in horizontal strakes, each 60 ins. wide, except the bottom strake, which is 36 ins. wide. The joints are single riveted, covered on the inside by the horizontal arch angles and on the outside by cover plates. This sheathing performs a complex function; it acts as a web member against vertical shearing forces; it receives the water pressure and transmits it to the frames, and it acts with the frames to resist general structural strains.

In closing these paragraphs on construction a few words need to be said in explanation of the operation of the air chamber. When the leaf is closed and the rising level in the lock presses it against the sill, the bottom of the leaf as well as the vertical surface is exposed to pressure and a tendency to lift the leaf off its bearings is produced. As soon as the level of the water in the lock reaches the top of the air chamber it enters the leaf and thereafter as the water level rises the increasing weight of the water on top of the air chamber counterbalances the increasing pressure on the bottom. As the bottom of the air chamber has an area greater than the top and as the top of the air chamber is 2½ ft. above normal pool level the total upward pressure on the bottom of arch No. 18 exceeds the downward pressure on the top of arch No. 8, and the leaf requires a considerable preponderance of weight over buoyancy when swinging freely in order not to be lifted off its bearings when closed. This preponderance when moving is 22.7 tons at extreme high water and 52.2 tons at extreme low water, while the remaining stability when the lock is full is 5.8 tons.

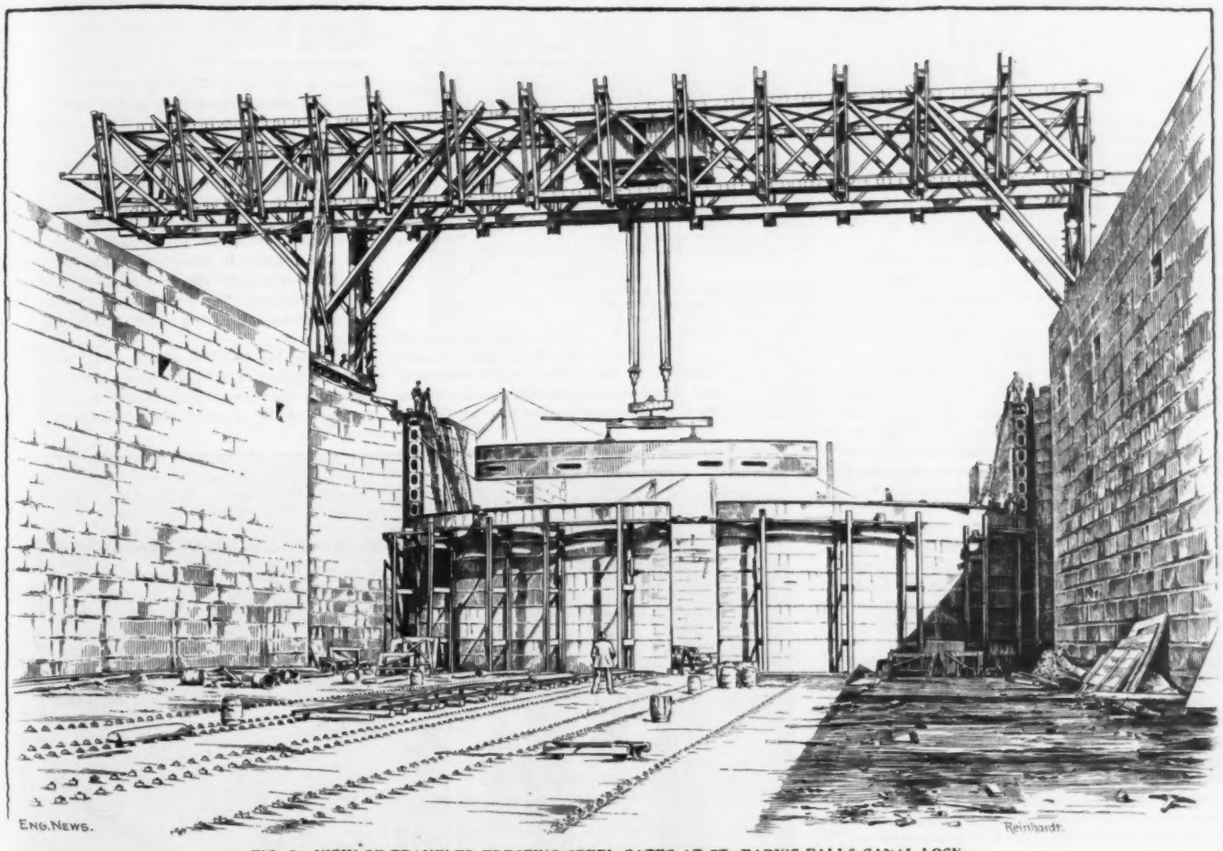


FIG. 2.—VIEW OF TRAVELER ERECTING STEEL GATES AT ST. MARY'S FALLS CANAL LOCK.

Shop Work.—The principal features of the shop work arose in connection with the work of assembling and the bending of the heavy plates for the quoin and miter posts.

The posts were assembled in their natural positions with sheathing vertical. Four horizontal cells, i. e., two sections, beginning at the bottom of the leaf were first erected, carefully supported and leveled, and then the reaming and riveting done. The bottom section was then removed, the second section lowered into its place and the third section erected on top of the second section, and this process repeated until finally the top section of the leaf had been reamed and riveted. By this process there was never any excessive height of material at one time. The reaming was done mostly by portable reamers, some driven by compressed air and some by rope transmission. Wherever possible the riveting was done by compressed air riveters.

Several methods were devised and tried in bending the curved plates for the quoin and miter posts but the apparatus shown by Fig. 1

was the most successful. The heated plate was taken from the furnace and, having previously raised the rollers and I-beam sufficiently by drawing the wedges (w), was slipped onto the cast-iron frame. The wedges were then driven, the I-beam screwed down, and then the arms (a) simultaneously lowered to a horizontal position wrapping the heated plate tightly around the planed surface of the former. With this machine the work was done very rapidly and successfully.

Table Showing Dimensions, Cost, Etc., of St. Mary's Falls Lock Gates as Compared with Other Large Lock Gates in America and Europe.

Place.	Clear opening.	Height of body.	Length of chord	Material.	Weight per leaf (tons of 2,000 lbs.)	Cost per leaf.	Date of construction.	Remarks.
St. Mary's Falls Canal:	Ft.in.	Ft.in.	Ft.in.					
800-ft. lock	100 0	43 0	56 8	Steel.....	157.5	$19,369	In hand	Fully arched, double sheathed.
Lock of 1881	60 0	38 6	35 7	Timber..	76.0	8,000	1880	Girders, trussed with iron rods.
Cascade Locks, largest leaf	80 0	54 0	51 4	Steel.....	158.5	*41,000	In hand	Fully arched, single sheathed.
David's Island	100 0	14 0	118 0	Timber..	114.5	14,055	1885	Rolling caisson spanning lock.
St. Nazaire	82 0	33 6	44 11	Iron.....	...	30,000	1874	Plano convex, double sheathed.
Havre, France: Bellot	98 6	35 9	53 4	Iron.....	171.0	26,000	1886	Vertically framed, double sheathed
Transatlantic	100 0	34 9	56 7	Iron.....	175.0	31,000	1884	Vertically framed, double sheathed
Transatlantic, old	100 0	32 2	56 7	Timber..	149.0	40,000	1861	Plano convex, back fully arched.
Dunkerque	69 0	27 9	38 4	Iron.....	49.0	6,500	1880	Vertically fr'm'd, with air chamber
Victoria Docks, old	80 0	31 0	46 4	Iron.....	110.0	10,800	1858	Fully arched, double sheathed.
Barry Dock	80 0	46 4	48 0	Iron.....	254.0	.....	1889	Both faces curved, double sheathed
Avonmouth Docks	70 0	45 0	42 10	Timber..	115.0	.....	1877	Fully arched.
Manchester Canal: Eastham l'k	80 0	45 5	45 9	Timber..	280.0	.....	1893	Girders strengthered, iron plates.

Erection.—The quoin post of each leaf was built up complete with foot plates at the shops and shipped in one piece. The horizontal arches were built up as complete girders and each leaf was shipped in horizontal sections, composed of two such girders connected complete, with the cover plate that connects each section with the next section above riveted in place at the upper outside edge of each section, and the two angle irons and horizontal web plate similarly riveted on the inside, so that in erecting, when one section was placed on top of the other, the outside sheathing was simply dropped down between the cover plate and the corresponding angle irons. The riveting necessary to be done in the field was that of riveting each section to the quoin post, and one horizontal row of rivets on both sides of the gate between each section. The angle irons for holding the vertical wooden cushions in place at the toe were riveted to the gate after each leaf was erected.

After erection, the air chambers were calked water tight and subjected to a test of 25 lbs. per sq. in., hydraulic pressure, before being painted. All accessible joints were calked with a patent calking machine operated with compressed air. The calking was a very tedious and expensive operation. Fresh air had to be supplied to the men while working on the inside of the gates. This was accomplished by means of tapping the main air pipe leading from the air compressor at the electric light station to the drills working on the lock floor. The work of erecting the gates is not quite completed. The intermediate lock gate is yet to be calked and tested, and it together with the lower lock gate are not yet painted. The work of erection was begun in July, 1894, and was continuous to November 5, 1895. The average number of men per day engaged on the work during that time was 19. Fig. 2 shows the traveler for handling the section of the gates during the process of erection. The gates were shipped by rail and unloaded on the north side of the canal. A special derrick had to be erected alongside the railway for unloading the sections, and a tramway laid from there to and along the north side of the lock. The maximum weight of a section was about 17 tons. Each half of the upper and lower guard gates and the upper lock gates weighed approximately 100 tons, and those of the lower lock and intermediate gates, 175 tons each. The following is the approximate weight and cost of the gates:

2,404,657 lbs. soft steel at 5.9 cts. per lb.		$141,874.76
119,168 " high steel at 27¼ " " "		32,473.28
36,167 " cast steel at 9¼ " " "		3,345.45
8,665 " cast iron at 6 " " "		519.90
5,322 " phosphor bronze at 35 cts. per lb		1,862.70
7,215 ft. B. M. oak timber at $60 per M.		432.90
28 pumps and fittings		2,100.00
Total		$182,608.90

The following are some of the principal weights and dimensions of the gates, which are collected here for easy reference:

Angle between chords of leaves when closed	170°	20"
Clear width of lock	100 ft.	..... ins.
Width between centres of abutting surfaces in hollow quoins	105 "	4.81 "
Rise of median line measured from line joining above centers	20 "	9.08 "
Height of body of gate	43 "	..... "
Radius of median circle	77 "	2.38 "
Length of median circle developed	57 "	11.90 "
Length of chord	56 "	7.69 "
Weight of swinging part in air	156.0 tons	
Manoeuvering weight, air chamber immersed..	22.7 "	
" " mean stage	37.9 "	
" " lowest stage	52.2 "	
Remaining stability, lock full	5.8 "	
Total thrust against masonry	1,650 "	
Horizontal pull on gudgeon in air	100 "	

The contractors for the gates were the Detroit Bridge & Iron Works, Detroit, Mich. All the soft steel was furnished to this firm by the Carnegie Steel Co., and the forged and cast steel by the Midvale Steel Co. The machining of the forged and cast steel was done by the Harlan & Hollingsworth Co., of Wilmington, Del.

A SPECIAL SHEARING MACHINE for cutting up old boilers into scrap is in use at the famous Horwich works of the Lancaster & Yorkshire Ry. The machine was built by De Bergue & Co., of Manchester, and it is stated that by its aid three men can cut up a steel locomotive boiler in an hour.

TESTING MACHINE OF 200,000 LBS. CAPACITY FOR THE UNIVERSITY OF NEW YORK.

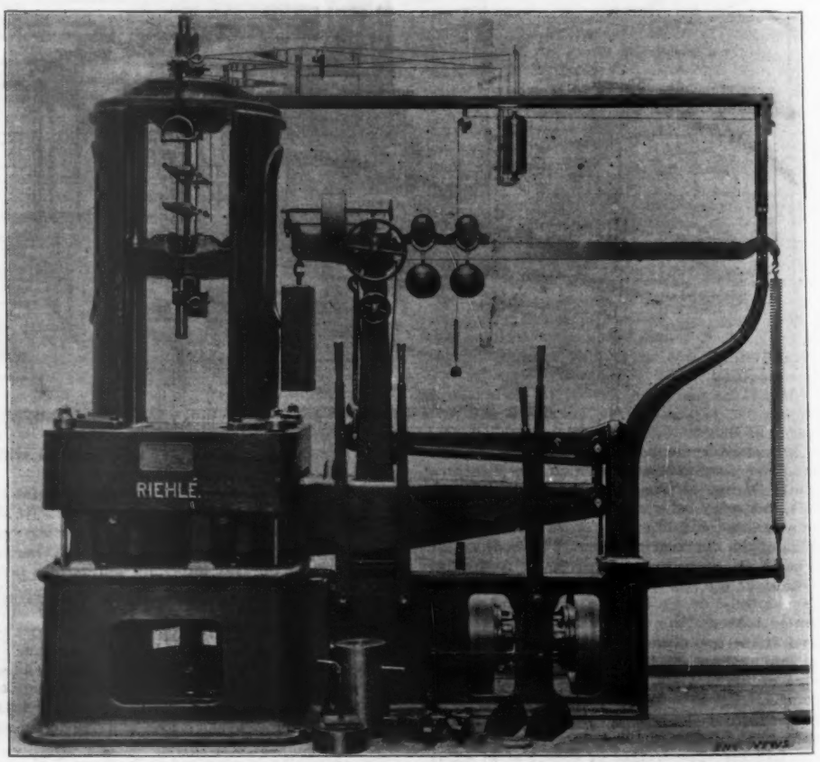
We illustrate herewith a new testing machine recently built by the Riehle Bros. Testing Machine Co., of Philadelphia, for the University of New York, in which are embodied a number of late improvements in machinery of this class, including the automatic recording attachment invented by Prof. Thomas Gray, M. Am. Soc. M. E., of Rose Polytechnic Institute. The machine was presented to the Engineering Department of the University by one of its undergraduate students.

The machine is 8 ft. 10 ins. high over all, and occupies a floor space of 3 ft. 7 ins. × 9 ft. 9 ins. Its shipping weight is 12,000 lbs. It will take tensile specimens up to 30 ins. in length, 2½ ins. diameter and 3 ins. square, transverse specimens 36 ins. long × 12 ins. wide, and compression specimens up to 24 ins. high. The various speeds obtainable are such that the head may be moved at 1-12, ¼, ⅛, ¾, 1, 2¼, 3¼, or 9 ins. per minute. The last speed, however, is not used for testing, but merely for setting the head. The extreme motion of the head is 2 ft. 6 ins.

The general construction of the machine will be evident from the engraving, but a few words of explanation may aid the reader. The top or fixed head is a steel casting resting on heavy columns, which are carried on the weighing table to which the name-plate is attached. The table rests on the knife-edges of the two main weighing levers, which transmit the pressure to the intermediate lever, which is in turn connected to the weighing beam.

The moving head is raised and lowered by two large vertical screws revolving in brass nuts secured to the head. The thrust bearings of these screws consist of hard steel balls rolling between the circular grooves of parallel plates. Spur-gears on these screws driven by a train of gearing leading to the driving pulleys effect the turning of the screws. Change of speeds or reversal of motion is effected by the hand levers seen in the cut, which operate clutches.

The apparatus seen at the top of the machine is the Gray automatic recording apparatus, which



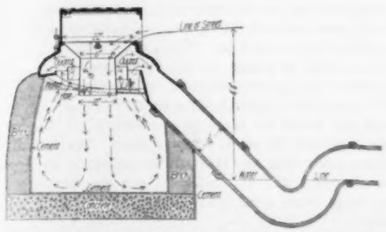
TESTING MACHINE OF 200,000 LBS. CAPACITY, WITH GRAY AUTOMATIC RECORDING APPARATUS.
Built by the Riehle Bros. Testing Machine Co. for the University of New York.

gives an autographic record both of the elongation within the elastic limit and of the total elongation up to the point of rupture. Briefly described it consists of two clamps fastened to the piece undergoing test and connected to a series of levers which magnify the elongation or compression of the specimen from 50 to 100 times, and move a pen up or down on a rotating drum, seen in the figure directly over the scale-beam. A detailed description with illustrations of this apparatus will be found in a paper by Prof. Gray, read before the American Society of Mechanical Engineers and published in its "Transactions," Vol. XIII., p. 633. It is also described in the "Digest of Physical Tests" for January, published by Frederick A. Riehle, Philadelphia.

A machine identical with the one illustrated, except that the Gray recording apparatus is omitted, has just been placed in the Washington gun factory of the U. S. Navy.

THE HERSHBERGER CATCH BASIN.

A catch basin especially designed to prevent blocking at the entrance while at the same time retaining all floating and suspended matter, is shown by the accompanying illustration. The water and matter carried by it enters the catch basin through a central inlet tube. The heavier



The Hershberger Catch-Basin. Made by the Bloomsburg Car Mfg. Co., Bloomsburg, Pa.

dirt sinks to the bottom, and as the water flows to the sewer the lighter material is retained by the bottom and edge of the overflow channel and by the guard.

The overflow channel, or gutter, for the basin shown, is 5 ins. wide, 1 in. deep, opposite the outlet pipe, and 6 ins. deep at the outlet pipe, the bottom sloping towards the outside. The circular guard is attached to the inlet tube by means of three iron braces. Two holes, one of which is shown in the illustration, each $1 \times 1\frac{1}{2}$ ins., pierce the inner side of the gutter. They are designed to lower the water in the basin 5 ins., after the surface flow into the basin ceases, thereby lessening the danger from frost and reducing the amount of water to be bailed from the basin into the overflow channel when it is desired to clean the basin.

No bars are placed across the inlet, it being desired that all rubbish shall enter the basin. It is claimed by the inventor that the combined area of the space at the guard is more than double the area of the usual entrance to basins and it is about six times the area of the discharge pipe. Special advantages are also claimed for the frost resisting powers of the basin.

The device was invented by Mr. Jos. Hershberger, Plymouth, Pa., and is now being made and put on the market by the Bloomsburg Car Manufacturing Co., of Bloomsburg, Pa. About 60 of the basins are now being put in at Binghamton, N. Y.

HEATING A COTTON MILL FROM THE HOT WELL OF A CONDENSING ENGINE.

The following description of a novel system of mill heating is taken from a paper read by Mr. Geo. W. Weeks, agent of the Lancaster Mills, at a recent meeting of the New England Cotton Manufacturers' Association, and describes the system in use at those mills. We reprint the abstract from the "Providence Journal," and may remark that while the so-called technical matter published in the ordinary newspapers is apt to be worse than useless, the "Journal" is notable for the excellence of its articles on engineering subjects:

The Lancaster Mills are four stories high and have a basement, and are heated from the water discharged from the hot well of a compound engine driving the mill, and the air is forced through the heater and flues by the flywheel. A small engine and blower are used nights and Sundays when the large engine is not running.

The ordinary Corliss flywheel forced sufficient air for this purpose without alteration (it was found that the air pressure in one of the Corliss wheel pits equalled 1½ ins. of water), but the wheel of the engine used in the mill being made with arms so shaped as to pass through the air with the least resistance, it was necessary to add "wings" to them. This wheel is 16 ft. in diameter and runs at a belt speed of 4,000 ft. per minute. After the wings were attached there was obtained a movement of 8,000 cu. ft. of air per minute through the flues and mill with an expenditure of 3 HP., as shown by the indicator.

The air is taken mostly from the basement, where it enters from out-of-doors and largely from the connecting boiler house.

The heater is situated in the air duct leading to the flue, and consists of eight sections, each 42 ins. high by 28 ins. wide, with 204 ½-in. pipes, each 90 ins. long. These sections are connected by pipe with the hot well, and so arranged that the end covers and diaphram causes the hot water to flow by gravity through half of the pipes in one direction and return through the other half, and then continue through the other sections in the same manner, and discharging where the air enters.

Small pipes were used in order to obtain the largest amount of heating surface in a given space, but as there is more heating surface than is needed, it would have been better, perhaps, to have used larger and fewer pipes so as to offer less resistance to the passage of the air.

With water from the hot well at 115° F., the air is heated to 100° F. In one test air was taken directly from out of doors, at a temperature of 26° and sent to the mill at 107°, with water taken from the hot well at 123¾° and discharged from the heater at 97½°. In practice the air is heated to within about 10° of the water used.

While heating the mill in December, before the large engine was started, the fan engine was run, exhausting the steam in the same heater. After the large engine was started, the fan was driven by belt from this engine, using hot water from the condenser of the heater, and while the walls were still wet, the mill having just been completed, with only a few looms in operation, 12,000 ft. of air per minute was forced into it, this being sufficient to heat it while in that condition. This required 8.81 HP., as shown by the indicator on the engine. As soon as the "wings" were put on the arms of the flywheel, the mill was heated with 8,000 cu. ft. of air per minute, as the looms were nearly all then in operation, and that was sufficient. It took 3 HP. only to furnish this air from the flywheel.

The blower was not arranged to be run at a speed to force 8,000 ft. per minute, but judging what it would take from the 12,000 ft., it would doubtless require 5¾ HP. to force 8,000 ft., or nearly double that required by the flywheel.

The use of the vapor on its way from the cylinder to the condenser, to add any heat needed to the air after passing the water heater, was suggested, but was not adopted, as the temperature at this point is only about 134°, while the weight of water in this vapor is very small as compared to the weight of water in the hot well, and this heater being a part of the condensing apparatus, would have to be absolutely tight, and as a consequence be rather costly. So, as the vapor was not utilized, a supplementary heater made exactly like the water heater was placed in the air duct between the water heater and the mill, taking the steam from the receiver between the two cylinders of the compound engine to heat it. This heater also takes the exhaust steam from the fan engine nights and Sundays. It was found that no steam was required in this heater while the mill was in operation, except in extremely cold weather, and last winter none at all was used in it.

It requires about double the heating surface to heat with water that it does to heat with steam, but as water heaters have to sustain no pressure, they can be furnished for a very little more than steam heaters made in the usual way.

Hot or cold water can be showered into the duct in the usual way when desired. When the weather becomes warm enough, so that no heat is required in the mill, the water from the condenser is turned off, and the engine flywheel continues to force the same amount of air through it for ventilating and cooling, and for this latter purpose cold water can be turned through the pipes in the same manner as water from the hot well.

During the time this plant has been used, it has required no repairs and has demonstrated that it will heat and ventilate the mill during the running hours with no expenditude for steam or power beyond the 3 HP. added to the engine as stated; that 100° temperature is sufficient to satisfactorily heat the mill, and that the air can be heated to this temperature, with water from the hot well with no loss of power, and the experiments tend to show that it is more economical (when the uptakes are built into the walls) to send a larger amount of air at a lower rather than a smaller amount at a higher temperature. Air heated to 97 7-10° at the heater is delivered to the fourth story at 94½°, showing a loss of only 3 2-10°, while the air at 124° at the heater was delivered at the fourth story at only 113°, showing a loss of 11°.

Much of the steam used to run the small blower engine, immediately after shutting down at night, and before starting up in the morning, is obtained without extra cost, as considerable of this would otherwise be blown off from the boilers at these times.

ROAD BUILDING IN LANCASTER, MASS.*

By Harold Parker.

The character of the country within the limits of Lancaster is favorable to the building of roads, as they can be easily drained. The soil is, in many places, composed of clean gravel, which, when properly selected and spread, will make a satisfactory road.

The town maintains nearly 100 miles of public highways, and expends for this purpose about $10,000 a year. New roads are constructed under special appropriations. The above amount is sufficient to keep all the roads in good condition, if they should be once made good. Nearly all the roads have been reconstructed within the past few years at considerable expense; and this has reduced materially the annual cost for maintenance, and made it possible to keep in good order a large number of routes and highways. This is mentioned to show that the sentiment of the people at large is changing in favor of permanent improvements.

The conditions are those of an ordinary country town, with the addition perhaps of the increased hauling of stone and wood to Clinton. There is also a very large amount of pleasure driving and bicycling.

The roads are classified roughly into three grades:

1. The main street and thoroughfares leading from it. The main street is a long road lined with houses, and so much used that the best gravel, spread in the ordinary way, will not answer except in summer. The following method has been successfully used: The roadbed was prepared with care both as to its crown and grade, stones about 4 to 5 ins. thick were placed on this, with the smaller part up when possible; on this were dumped smaller stones of nearly uniform size, and then evened off to give a surface corresponding with the finished cross section of the road; on this surface were placed still smaller stones which had been screened in the pit. These should be thoroughly rolled with a heavy roller and covered with a thin layer of clean gravel, which should also be rolled again after being thoroughly sprinkled. The objection to this road is that the gravel pounds up into powder, and this makes dust in dry weather and mud in wet. The cost of this road finished is from 30 to 35 cts. per sq. yd., which includes the cost of moving the old roadbed where necessary. The crown of this road is 1 in. in 2½ ft.

2. The roads outside the main line of travel. These are the ordinary gravel roads, and are made of the best selected gravel within reach. The larger stones are removed with a fork by a man placed on the cart while loading. Under the same conditions the gravel is screened. All cobble-stones collected either in the pit or elsewhere are used in road foundations and are covered by gravel. In this way all the roads are gradually getting stone foundation. Treated in this way, they stand up very much better while the frost is coming out in spring and are more easily repaired. In repairing in spring, where the roads are rutted, the road machine or scraper is used. Where the ruts are merely a displacement of the gravel, the scraper is made use of to replace it and remove the rut, but care is taken not to cut out a gutter or into the surface of the road in any way. A rake and shovel are then used, the surface is made even, and all loose stones, sods, and worn-out material are carefully removed; this refuse matter is dumped on the road side in two places, smoothed off and covered with loam on which grass readily grows, and this adds to the safety of the road as well as improving its looks. Particular care is used to prevent the grass from choking the water-way by the road side.

3. The unfrequented roads used mainly for hauling wood from wood lots to market and for pleasure driving in summer. Very few communities can do more than keep such roads good in summer, or from the time the frost is out of the ground in the spring until it freezes up in winter. The main thing to do is to keep as smooth and perfect a surface as is possible, fill up ruts as soon as made, remove all material that will interfere with the immediate escape of water, and all stones. In this case a road scraper can be used to great advantage, provided it is followed up at once with rake and shovel. The edge of the sod on road sides is cut with care, a line being used in order to get it straight, and offer as little obstruction to the passage of water as may be. Men are constantly employed in removing all loose stones from the roadway, which are carried to a point convenient for future use and are so piled that stones of the same size are placed by themselves. In this way the roads are gradually improving.

*From the "Journal of the Massachusetts Highway Association."

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We wonder how many mills and factories there are in this country in which the workers of all grades, from the manager down to the errand boys, are sweltering and suffering in these hot summer days, while just beside the mill there flows a stream of cool water. We wonder how many times in such mills men have looked out of the windows in hot August days and envied the fishes in the river below.

Probably thousands or tens of thousands have done this, and it is safe to say that quite a number must have had at least a wish that it were possible to distribute some cool breaths from the river through the hot stuffy rooms of the mill. And now it appears that up in New England some one has had the courage to break away from beaten paths and established precedents and actually do what thousands have wished were possible. He has done it moreover by methods and apparatus so simple that the wonder is that they have not been generally applied before.

In another column of this issue we print a brief description of this interesting new departure. Briefly told, it is a blower system for heating and ventilating, in which the pipes of the heater are filled with water from the hot well of the condensing engine instead of with steam. Of course, in hot weather it is a simple matter to force cold water from the river through the pipes instead of the hot water, and thus to distribute cool air instead of warm air. Another notable feature of the system—of course not an essential one—is the use of the fly-wheel of the main engine as a blower. Everyone who has stood near a great fly-wheel knows what a powerful blast it creates. The designer of this system has had the common-sense to utilize this to circulate the air over the heating pipes and through the conduits which distribute it to the various rooms of the mill.

It appears to us that there are some excellent features in this novel plant. In the first place we have the fuel economy of a condensing engine, combined with the economy due to the use of the waste heat of the engine for heating purposes, the same as when exhaust steam is used. It must be borne in mind that there is just as much heat in the water from the hot well, as there is in the steam that enters the condenser. It is at a lower temperature it is true; but to offset this it gives up its heat more readily, and as a heater using water does not operate under pressure it can be made very cheaply. By the use of the fly-wheel as a blower, not only is the cost of the power to run a separate blower, by a belt or a separate engine saved; but the cost of attendance and repairs, always apt to be heavy on machinery of this class, is also saved.

We regret that we have not yet been able to learn the name of the designer of this plant so as to give him the credit that is his due in publishing the description. It appears to us a most creditable piece of mechanical engineering, and one which could be studied with profit by any one interested in the problem of mill heating and ventilation.

A correspondent calls our attention to the fact that our note of last week, in which we referred to Manhattan Island as the only place in the United States where the erection of overhead wires for electric railways is forbidden, is incorrect, as in Washington, D. C., a Congressional statute now forbids the erection of trolley wires. It is true that two street railway companies in Georgetown still use overhead wires; but their systems were built before Georgetown was made part of Washington. Our correspondent sends also the following additional note on the operation of the electrical conduit railways in Washington:

> The portion of the street railways operated within this city have horse, cables or underground electric systems. Congress seems to be firmly insistent on this policy. At the last session it authorized an experiment by one of the street railway companies in the use of compressed air motors, but required that in the event that system should not prove satisfactory to the municipal authorities that the company shall substitute an underground electric system.
>
> The underground systems in use here seem to give full satisfaction in their mechanical operation, and are not more objectionable in other respects than other street railways.

The amended specifications under which Jersey City is for the sixth time inviting bids for a new water supply, noted briefly in another column, have been improved in some particulars, but still shut out all real competition for furnishing a gravity supply, and render the reception of bona fide bids for filtered water very unlikely. Under the new specifications the city reserves the option to purchase the works only at the end of each of the first three five-year periods of the contract, instead of at any time during the contract, as has heretofore been the case. This is in some respects a good change, as the contract will thus be surrounded with less uncertainty for the contractor. Another feature that might prove advantageous to the city is the giving of an opportunity to bid on delivering a part of the gravity supply to high and a part to low service, instead of all of it to either one or the other.

We are pleased to see that the filtration specifications are more liberal and reasonable than heretofore, though still requiring the construction of a pumping plant and force main to deliver the filtered water to the city reservoir and giving only three weeks or so for the preparation of bids. The standard of purity, it is interesting to note, omits the requirement that the contractor shall name the amount of chlorine that the filtrate shall contain, and adds one for the number of bacteria, both most sensible and excellent modifications. But the contractor is still required to guarantee the amount of nitrates in the filtered water, which, as we explained in our issues of April 30 and May 14, is a curious provision, to say the least. The filtration specifications appear to be drawn broadly enough to permit bids on any system until the specifications for the standard of purity are reached. These are so framed as to practically exclude mechanical filtration, or any system except slow sand filtration. Under the latter process contractors are left entirely free to design their plant as they see fit, instead of being limited in certain details, as before.

THE GRADE CROSSING COLLISION AT ATLANTIC CITY.

The most serious railway disaster that has occurred in this country for eight years, took place at a grade crossing of the Pennsylvania and Philadelphia & Reading railways, about two miles from Atlantic City, N. J., at 6:50 p. m., July 30, resulting in the death of 46 persons and the injury of about 60. The accident is the most fatal that has ever resulted from a grade-crossing collision, so far as our search of the records shows, and is exceeded in the number of its casualties by only five railway accidents that have ever occurred in this country.

The following account of the circumstances in connection with this terrible disaster we have gleaned partly from the very full newspaper reports which have been published, but chiefly from the reports of the Coroner's investigation, now in progress at the time this is written, and from facts reported direct to us by an engineer who visited the site of the disaster a few hours after the occurrence.

The Pennsylvania line, known as the West Jersey & Atlantic R. R., is a single track road, running from Atlantic City northwest and closely paralleling for a distance of several miles across the swamps the double track line of the Philadelphia & Atlantic City R. R., operated by the Philadelphia & Reading Co. The two lines cross at grade at a point just outside the limits of Atlantic City, as shown on the accompanying map, and just beyond that point the West Jersey line joins the tracks of the Camden and Atlantic R. R., also a Pennsylvania line.

The crossing is at an angle of about 15° and is protected by an interlocking machine operating home and distant signals on both lines, but with no derailing switches. The home signals are 197 ft. from the crossing on the west side, from which direction trains approach at the highest speed, and 107 ft. on the Atlantic City side. The distant signals are 1,050 ft. from the crossing, on the west side, and 950 ft. on the other side. Track instruments operating electric annunciators in the tower are placed 5,227 ft. distant from the crossing on the west side, and 5,066 ft. on the Atlantic City side.

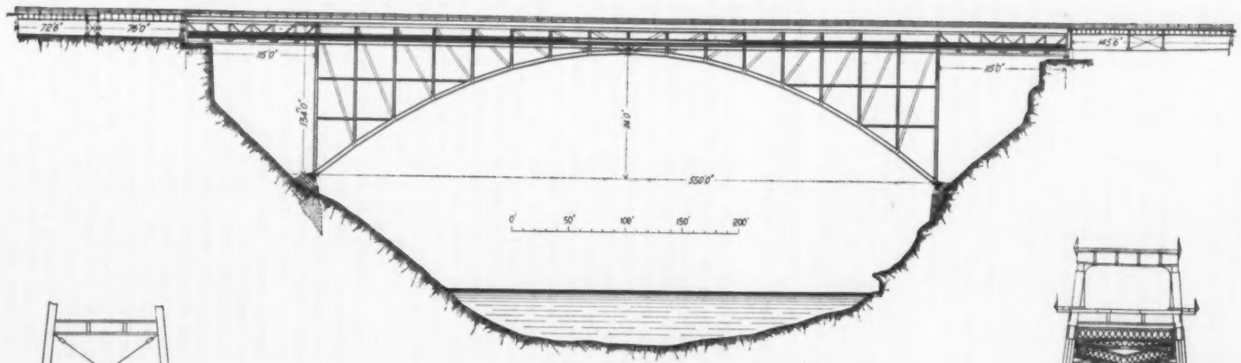
The crossing was established in 1886, under an agreement dated June 18, 1886, under which the Pennsylvania, as the company desiring to make the crossing, assumed the expense of its construction and also of its maintenance. The rules adopted for the use of the crossing and agreed to by the Superintendents of both roads, Aug. 11, 1886, were as follows:

> All engines and trains must approach the crossing carefully, prepared to come to a full stop at a distance of 150 ft. from the point of crossing, unless the proper signal for passing is displayed by the signalman in charge.
>
> In case of an engine or train approaching either crossing upon both roads at or about the same time, priority in the right of passage will be regulated as follows:
>
> 1—Passenger trains as a class.
> 2—Freight trains as a class.
> 3—All other trains as a class.
> 4—Engines without trains as a class.
>
> But as to each class the trains or engines of the P. & A. C. R. R. will have priority over the trains or engines of the W. J. & A. R. R. at the crossing north of Atlantic City, and the trains or engines of the W. J. & A. R. R. and C. & A. R. R. will have priority over the trains and engines of the P. & A. C. R. R. at the Baltic Avenue crossing, Atlantic City. No unnecessary detention to be caused to the trains of either road.
>
> The signals used will be the Semaphore Distant and Semaphore Home at the crossing north of Atlantic City, and the Semaphore Home at the Baltic Avenue crossing, Atlantic City.

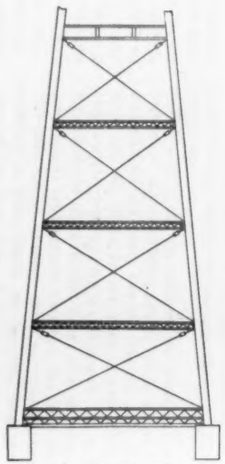
The instructions as to signal indications which followed the above are merely those in practically universal use.

The events at the time of the accident were as follows: An excursion train, made up of a locomotive and six cars, heavily loaded, left Atlantic City, on the West Jersey road, about 6:30 p. m., and while crossing the southbound track of the Philadelphia & Atlantic City line at the above junction, it was struck between the first and second cars by an express train on that track. The locomotive demolished the second, and the third cars of the excursion train and the two following cars were telescoped more or less by the collision. It was in these four cars that practically all the casualties occurred. The locomotive and baggage car of the Reading train were wrecked and the engineer was instantly killed. The passenger cars of this train did not leave the track and their occupants were not injured.

After the accident the signals were found to be set to give a clear track for the West Jersey train, but both the home and distant signals of the Reading were at danger. The day towerman, Nicholas Long, testified before the Coroner's Jury



General Elevation.



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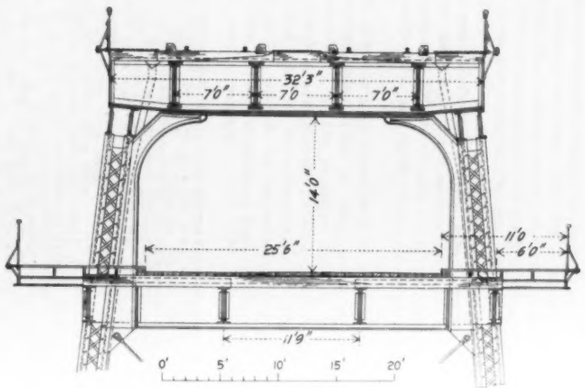

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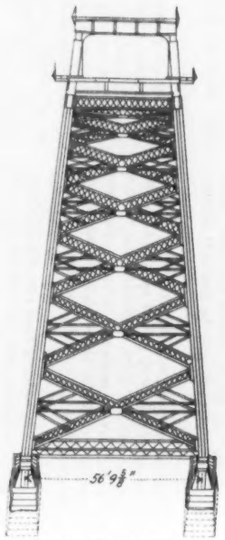

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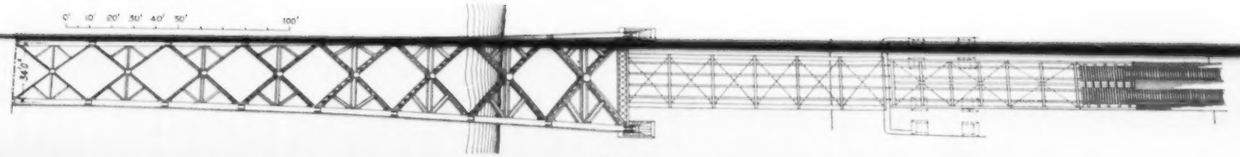
Typical Cross Section.



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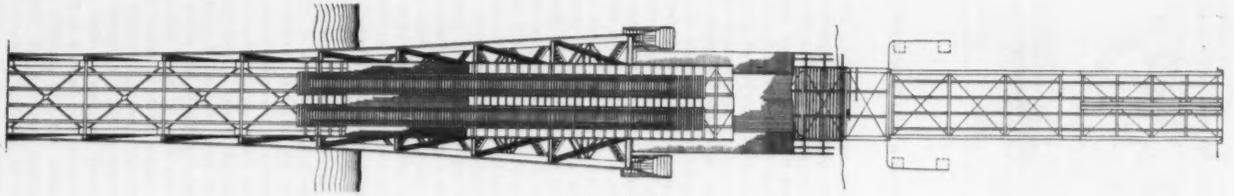

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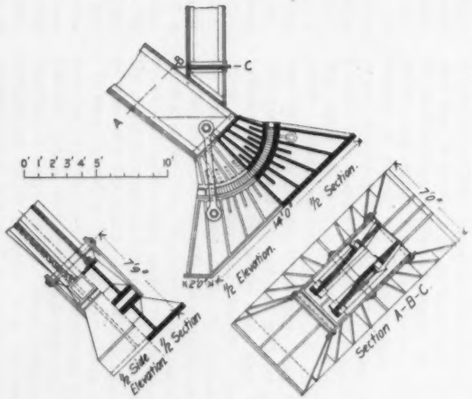

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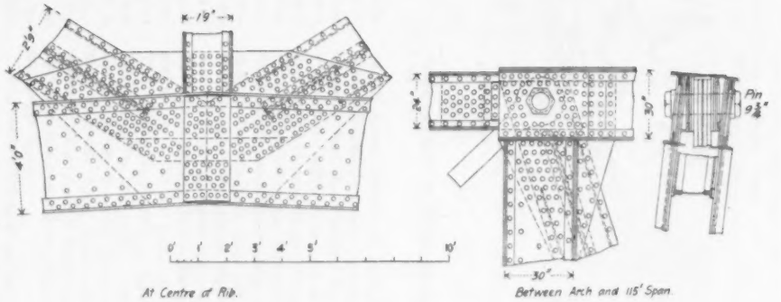


Details of Connections.

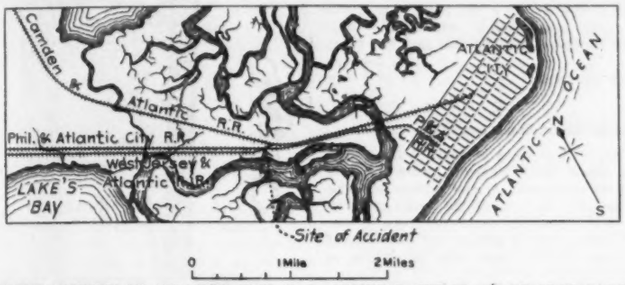
THE NEW STEEL ARCH TO REPLACE THE RAILWAY SUSPENSION BRIDGE OVER THE NIAGARA GORGE.

Leffert L. Buck, M. Am. Soc. C. E., Chief Engineer. The Pennsylvania Steel Co., Contractor.

that he left the tower in the charge of Geo. Hauser, the night towerman, at 6:40 p. m., and all signals were then at danger. Long had gone but 800 ft. from the tower when he heard the Reading train whistle and saw it coming a half mile away. At the same time he saw that the West Jersey train had the clear signals and was moving slowly toward the crossing. He watched, expecting to see the Reading train stop, but instead came the collision. He then went back to the tower and verified the position of the West Jersey signals. The distant signal on that road had then been thrown to caution behind the train, as is customary.

It will be apparent that the only question as to the responsibility of employees for the accident is as to whether the engineer of the Reading train ran onto the crossing in disregard of the warning of both distant and home signals, or whether Hauser, the night towerman, may have given a clear signal to the Reading train, and afterward changed the signals in the face of the approaching train to give a clear signal to the other road. It must be said that the evidence thus far presented appears to show very strongly that the former supposition is the correct one, and that the dead engineer disregarded both signals, and thus caused his own death and that of nearly fifty others. His train was a fast express train and was accustomed to the right of way. The other train was a heavy excursion train moving at a slow rate of speed. The towerman had both approaching trains in full view. If he gave the Reading express a clear signal when it was so near the crossing as to call the engineer ahead, he would not have had time to then change the signals so as to bring the slow moving West Jersey train on to the crossing in advance of the Reading. To put the case still more clearly, the Reading train must have approached the crossing ordinarily at a speed of 40 to 60 miles per hour. (It is scheduled to make the run from Philadelphia to Atlantic City, 55 miles, in 65 minutes.) The West Jersey train, according to various witnesses, moved slowly up to and on the crossing under clear home and distant signals. Of course, while the signals on that road stood at clear it was impossible for the towerman to have given a clear signal on the other line. Again, the day operator, Long, testified that if he had been in the tower he should have given the Reading train the right of way, and further that he had not stopped a Reading express train for three years. Evidently, then, it was an exceedingly unusual thing for the engineer of the Reading train to find the signals against him at this crossing. Experience has shown that habit is a most powerful factor in influencing men's actions, and the evidence seems overwhelming that the engineer approached this crossing at high speed, expecting to find it clear, as he had hundreds of times before, and in a moment of absentmindedness, he failed to notice and to realize the warning of the signals until it was too late to stop his train. We have said that he approached the crossing at a high rate of speed. The schedule time compelled fast running on the open road. The train left Camden 2½ minutes late and had made up 1½ minutes of this when it passed Pleasantville, three miles above the scene of the collision. But, although the train doubtless approached the distant signal at high speed, it is certain that its speed had been materially reduced when it struck the other train at the crossing. Had this not been the case the locomotive would have, in all probability, cut right through the other train, and it did not do this, but was itself diverted and thrown into the ditch without crossing the West Jersey track. Again, had the Reading train been moving at high speed, its cars back of the baggage car would, in all probability, have left the rails, and some casualties would have occurred to their passengers.

Since the above was written we have received the testimony given before the Coroner's Jury on Aug. 4, when Hauser, the towerman on duty at the time of the collision, gave his evidence, and the conductor, brakeman and fireman of the Reading express train and the engine crew of the West Jersey train were examined. The testimony of all these witnesses agreed very closely and fully corroborates the opinions stated above. It appears that the Reading train passed Pleasantville, three miles from the scene of the disaster, at a speed approaching 60 miles per hour. It was running probably not less than 50 miles per hour as it approached the distant signal. The point at which the engineer shut off steam and applied the brakes is uncertain, but it was probably not less than 900 ft. from the crossing and they may have been applied 100 to 200 ft back of the distant signal or 1,150 to 1,250 ft. from the crossing. The brakes appeared to have held well, as the brakeman on the train testified that he was thrown to the floor by the shock of their application, but the train was running at too high a speed to be stopped before it reached the crossing, and it struck the other train at a speed of 12 to 15 miles per hour.



RAILWAYS IN THE VICINITY OF ATLANTIC CITY, N. J., SHOWING SITE OF GRADE CROSSING DISASTER OF JULY 30.

It appears then that so far as the responsibility of employees are concerned, this terrible accident was due to an error of judgment of the engineer in approaching a distant signal at too high a speed, expecting, doubtless, to see the signals change to safety as he approached them. This is not the first time by any means in railway annals that disobedience to fixed signals has been the cause of serious accidents. We recall to mind among notable cases of this sort, a rear collision on the Fitchburg, near Boston, a few years ago; a drawbridge disaster near New Orleans at about the same time, and, as a still more notable cases the terrible disaster on the Grand Trunk Railway at the Richelieu River, in 1864, in which the number of killed and injured were greater than in almost any disaster in the history of railroading, and which was caused by the engineer running his train into the open draw in absolute disregard of a danger signal.

It may be said to be almost an axiom of railway practice that the two most dangerous points on a railway are a drawbridge opening, and a grade crossing of two railways. Many states have laws compelling trains to come to a full stop before crossing such points; but experience has shown that even this traffic-delaying expedient is far from being an infallible safeguard. On Nov. 21, 1862, a Boston & Maine train after stopping at the station at Charlestown, moved forward into an open draw at a rate hardly faster than a man could walk, and the accident caused the death of six persons. Not to enumerate other instances, it is sufficient to say that it is generally recognized to-day that the best protection for either grade crossings or drawbridges is an equipment of home and distant signals operated by an interlocking machine which also operates derailing switches, which are opened when the signals are at danger. In some states, notably in Illinois, where the law formerly required trains to come to a full stop when approaching a railway grade crossing, they are now allowed to proceed without stopping over crossings equipped with interlocking signals and derails.

The best practice in the protection of grade crossings and drawbridges now requires that either should have derailing switches interlocked with the signals, and in addition that electric locking should be applied to the machine to prevent the towerman from changing the position of the signals after he has given a clear track to a train until it has passed over the crossing.

Undoubtedly the greatest lesson for railway managers in this accident is that it is not safe to dispense with derailing switches at grade crossings. We are aware that some railway officers object that a derailment may cause as serious results as a collision. It is true that it may, but universal railroad experience shows that it very seldom does.

It is to be borne in mind always in considering this question that the moral effect of the derailing switch is such that it COMPELS obedience to the warning of the danger signals as no rules or discipline that the best manager can enforce can possibly do. The engineer knows that the normal position of the signals is at danger, and when he approaches them and sees them against him he too often thinks that it means nothing more than that the tower-operator has been a little dilatory in throwing his levers. But if he realize that to run past a danger signal means absolutely and invariably that his train is going off the rails, he has a much more powerful motive to induce him to keep his train under control as he approaches such signals.

The few advocates of automatic braking attachments to signals will doubtless use the Atlantic City collision as a warning text to prove the merit of their systems; but it is by no means clear that a safety device of this class would have prevented this accident. The engineer did apply his brakes, but he did not apply them soon enough. To have certainly prevented this accident an automatic brake-setting device would have to have been located probably at least 1,800 ft. from the crossing, and such an apparatus would be a serious hindrance to trains running at slow speeds.

When we take into account also the complications and difficulties which any automatic brake-setting attachment to signals must involve, it seems to be clear that the derailing switch is the best means yet devised for compelling obedience to a danger signal, and insuring also against a catastrophe in case of the sudden death or incapacity of the engineer, the failure of the brakes or other causes which may send a train past a danger signal without the engineer being blameable.

If any of our readers are still of the opinion that it is too dangerous to throw a train onto the ties, we can suggest nothing better than a trial of the German "sand track," described in one of our recent issues. It would be an inexpensive matter to add a few lengths of rail to the stub end of a derailing switch and cover it with sand, and experiments show that the retarding effects of such a track is greater than that offered to a train running over the ties.

Besides the necessity of the use of derailing switches, it seems to us that more care should be taken in defining the meaning and use of the distant signal in the instructions to engine men. There is a too prevalent idea, we fear, that the distant signal marks the point where brakes should be applied for a stop at the home signal, in case the semaphores are both against the train. Every railway manager should try to eradicate this idea from the minds of his men. The point where the brakes should be applied depends wholly on the speed of the train. Very slow trains have no need of or use for the distant signal, save in times of heavy fog or storm. It may be claimed that distant signals should be set back from the crossing far enough to enable the fastest train to be stopped by applying the brakes at the distant; but with

some of the fast trains, running at speeds reaching 70 to 80 miles per hour, this would mean a great increase in the length of operating mechanism to the distant signal, additional trouble from temperature changes, etc., and greater difficulty on the part of the towerman in checking the movements of the distant signals. The better plan seems to be to keep distant signals where they now are (unless they are so located that they cannot be seen for some distance back) and give special instructions to engineers of fast trains respecting the speed at which distant signals may be passed.

It is a matter of history that the fall of the Ashtabula bridge in 1876, and ten years later the terrible disaster at White River, Vt., and at the fatal Bussey bridge had a great influence in bringing about a general inspection and overhauling of bridges and bridge floors, and the result was a great improvement in the railway bridges of this country. It is to be hoped that this fearful example of the dangers of grade-crossings may cause greater care everywhere in their protection.

As we stated at the outset only five railway accidents in the United States have ever resulted in a greater number of deaths. The principal facts concerning the seven worst accidents ever recorded on railways of the United States are summarized in the following table:

Date.	Place and railroad.	Kind.	No. killed.
May 6, 1853.	Norwalk, Ct. (N. Y. & N. H.)	Drawbridge.	46
July 17, 1850.	Camphill, Pa. (Phil. & Reading)	Rear collision.	66
July 15, 1864.	Port Jervis, N. Y. (Erie)	Head collision.	99
Dec. 29, 1876.	Ashtabula, O. (L. S. & M. S.)	Bridge.	92
Aug. 10, 1887.	Chatsworth, Ill. (T., P. & W'n.)	Culvert.	73
Oct. 10, 1888.	Mud Run, Pa. (Lehigh Valley)	Rear collision.	60 to 70
July 30, 1896.	Atlantic City, N. J. (Pa. & P. & R.)	Grade crossing.	46

THE RELATION BETWEEN PUTRID GASES AND typhoid fever, from the standpoint that such gases are predisposing causes of the disease, has been investigated by Dr. Giuseppe Alessi. By subjecting rats, guinea pigs and rabbits to an atmosphere containing the exhalations from excrementitious matter and later inoculating them with cultures of typhoid bacillus, watching the effects and making post mortem examinations of such animals as died, together with cultures from their organs, the doctor concludes that putrid gases predispose these animals to the pathogenic action of typhoid germs. Further and exhaustive studies led to the belief that the predisposition is caused by a combination of the gases given off by putrefaction, and not by any one of them, the animals being subjected to ammonia, sulphuretted hydrogen, carbonic acid, and other less well known gases, and subsequently inoculated with the typhoid bacillus. Long-continued breathing of the combined gases of putrefaction seemed to diminish the predisposition under discussion, but not to terminate it, although the experiments were limited in point of time. While discrediting the old theory which made the gases of putrefaction directly responsible for typhoid fever the experiments strongly confirm modern hygiene in its teachings that sewer air and other bad air should not be breathed. We are indebted to Mr. H. Alfred Roechling, Assoc. M. Inst. C. E., 14 Market St., Leicester, England, for a copy of Dr. Alessi's paper, reprinted, we suppose, for private circulation. The paper was translated by Misses E. and C. Harvey and contributed by Mr. Roechling to The Sanitary Institute, of which Mr. E. White Wallis, Parkes Museum, Margaret St., London, is secretary.

LETTERS TO THE EDITOR.

Summer Uniforms for Railway Employees.

Sir: American railway officers are as a rule noted for their practical good sense; but I have noticed of late what seems to me a great oversight on their part. During the hot weather of the present summer, when heat and humidity were competing to see which should do the most to make humanity suffer, and when everyone felt as if Adam's original costume were clothing enough, I have observed the conductors on several of our important railways sweltering and suffering in the heavy blue "Prince Alberts," which they are obliged to wear. It certainly ought to be possible to devise a uniform for summer wear, which would be far more comfortable, and I am sure that passenger trainmen and other railway employees would greatly appreciate the change. No man can perform his duties as well when bodily discomfort is constantly distracting his attention; and I believe that railway managers would find that uniforms for their employees suited to hot weather would pay large returns in the way of a better-looking and more polite staff, more alert in the performance of their duties. S .M. K.

New York, July 29, 1896.

Which Side of an Oak Tie to Lay Down.

Sir: Referring to the query of R. W. W. in your issue of July 23, as to which side of an oak tie should be up when laid in a dirt roadbed, one side having full face and the opposite side having corners rounded off, I think the rounded side should generally be placed up. Such a tie is frequently made from a tree large enough to make two ties to an 8 ft. section of the trunk, or what is commonly called a "split tie." If laid with the rounded side up, the grain of the wood will have a tendency to shed the water, whereas if laid with the full face, or heart side, up, the grain will tend to carry the water to the center of the tie. There would probably be at least ½-in. of sap at the rounded corners, and if placed down it will commence to rot quicker than if turned up; for in the latter position it will stand a better chance to dry out after rains. The full face side down will also hold better in the tamping. The rounded side will not give as good bearing for the rail, but in a dirt track it is fair to asume that the traffic is not heavy, consequently there will be no serious cutting of the rail into the tie. Yours very truly, F. G. Jonah.

Marine, Ill., July 27, 1896.

A Region Where Times are Good.

Sir: In this Bayou Lafourche section of Louisiana everything is on a boom. Good crops and plenty of money makes business good anywhere. A new railway is being built from the Mississippi River down the banks of Bayou Lafourche which will ultimately reach Lockport, a distance of about 60 miles. An ice factory has been started in Napoleonville and there is some talk of putting in water-works. Mr. Leon Godchaux, the largest sugar producer in the United States, is putting in an immense sugar mill and remodeling his Elm Hall refinery, enlarging its capacity from 900 tons per day to 1,200 tons. This is done to enable him to handle the enormous crop of 90,000 tons which he confidently expects to cut from this enormous estate. It is expected to turn out this season no less than 12,000,000 lbs. of fine quality "white granulated" sugar. The railway system on this plantation, consisting of 10 miles of track, will be extended about 4 miles, to enable him to handle the crop more expeditiously. Another 12-ton Baldwin locomotive will be added to the rolling stock. The track is of first-class steel rails with frogs and switches of the latest design.

A week ago the sugar house on the Souvenir Plantation, owned by Mr. Godchaux, was destroyed by fire. The loss amounted to $75,000. Within 12 hours after the fire started the plans were made and an order placed for a new refinery to take the place of the one burned. The contract calls for a complete sugar house, to be ready for grinding by Oct. 15 of this year. The new house will be of the latest design and double the capacity of the old one. W. Irving Willis.

Napoleonville, La., July 26, 1896.

Bride's Sewer Flushing Device.

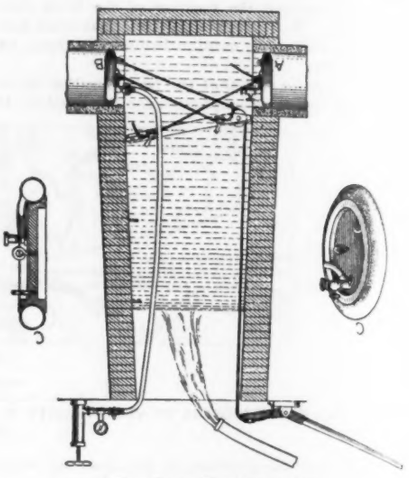
Sir: I enclose herewith a cut and description of a sewer flushing device which may be of interest to your readers. At the request of the inventor I gave it a trial on our sewers here and found it to work most satisfactorily.

In connection with the criticisms of flush tanks (see Eng. News, June 4, 1896), in the report of the annual convention of the American Water-Works Association, an inspection of this device is recommended.

Yours truly, Morris Hacker,
Civil Engineer Chevy Chase Land Co.

Chevy Chase, Md., June 22, 1896.

(The device in question is a stopper consisting of a circular block with a rubber ring around its rim. The ring is inflated after the stopper is inserted in the pipe, or pipes, leading from the manhole, thus making a water-tight seal. The manhole is then filled with water from a hose, or any other means provided, after which the stopper is suddenly withdrawn by means of the lever and accessories shown in the illustration. Mr. C. T. Bride, 129 B St., S. W., Washington, D. C., controls the device, which he states has been used by the sewer department of the District of Columbia.



A New Sewer Flushing Device.

It is, of course, no new thing to flush sewers by plugging the pipes leading from manholes. Where that system is in vogue this device may prove much more advantageous than some of those already in use, but automatic flush tanks will still be found advantageous and even necessary in many cities.—Ed.)

The Modified Darcy Formula and the New Westminster Steel Main Gagings.

Sir: So much attention is now being given to the very important practical question of how much water we may expect a pipe of given material, diameter and hydraulic gradient, and laid under ordinary practical conditions, to deliver, that such a communication as that contained in your issue of July 30, under the title of "Flowage Test of a 14-in. Riveted Steel Pipe," cannot fail to be interesting.

In this test the data were as follows: Observed discharge, 0.49 cu. ft. per sec.; fall per 1,000, 0.455; diameter, 1,167 ft.; character of pipe, riveted steel, rivets not countersunk. Applying the modification of Darcy's well-known formula for rough cast-iron pipes already communicated to your paper upon a previous occasion, we find an exact correspondence with observed results.

In order that your readers may check this assertion, if they see fit, I will give the generalized formula of Darcy, as follows:

$$Q = \sqrt{D^5 . h},$$

in which Q = cu. ft. per sec.; D = diameter in feet, and h = fall per thousand.

Inserting the given factors:

$$Q = \sqrt{1.167^5 \times 0.455} = 0.99 \text{ cu ft.}$$

as observed.

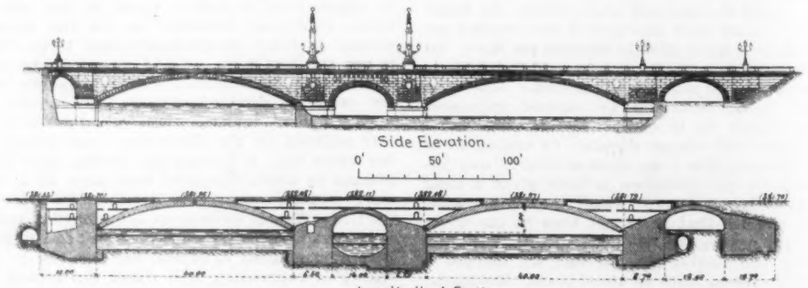


FIG. 1.—LONGITUDINAL ELEVATION AND SECTION OF COULOUVRENIERE CONCRETE ARCH BRIDGE, GENEVA, SWITZERLAND.

From this it would appear that a new riveted steel pipe of the character described in the report is under the same conditions as regards discharge as a rough cast-iron one. After some years of service the above pipe will no doubt give a reduced delivery.

I have already taken occasion to call attention to the great simplicity and practical utility of the above generalized formula. It is adapted to the case of very rough cast-iron pipes, and will therefore in many cases give too small a discharge; in other words, it contains a factor of safety, as all practical engineering formulas should do. By a curious cancelling of factors, if we make Q = U. S. gallons per minute, and D = diameter in inches, then the above formula gives a discharge about 10% greater than for feet and seconds, and in many cases this would be nearer the truth than the original formula.

E. Sherman Gould,

Ortley Beach, N. J., July 30, 1896.

Notes and Queries.

A. O. G. asks where iron sidewalks are manufactured and what are their merits and faults?

THE COULOUVRENIERE CONCRETE ARCH BRIDGE, GENEVA, SWITZERLAND.

The success with which concrete, with or without a metal skeleton, lends itself to aesthetic treatment in the construction of street and park bridges has been mentioned often in Engineering News, and from time to time prominent American structures of this type have been described and illustrated in its columns. In Europe, however, the use of concrete for roadway bridges has been more extensive than in this country, and it was in Germany that the well-known concrete and iron constructions of Monier and Melan were first developed and exploited. But, besides these combination structures, concrete arches without metal skeletons have been built to a considerable extent in Europe, and European engineers are not infrequently found who prefer them to any of the patented constructions. As an example of this non-skeleton construction we illustrate herewith the Coulouvreniere Bridge, a concrete bridge of two 131.2-ft. spans, recently completed at Geneva, Switzerland. Besides its handsome appearance this bridge is notable for the boldness of its design, considering the material used and for numerous structural details which are not exemplified by such concrete arches as have been constructed in America up to the present time.

The Coulouvreniere Bridge crosses the River Rhone at Geneva, Switzerland, and was constructed to replace a bridge built in 1857, which in aesthetic qualities and strength had become undesirable. It was decided that the new bridge should be of concrete and should consist of two main arches separated by a central pier of considerable width, but the details of its construction and design were opened to competition. Designs were presented both for combination concrete and iron constructions and for articulated concrete construction, and the latter construction was adopted as preferable by the experts, who were Prof. Ritter, of the Zurich Polytechnic School, and Mr. Elstres, Engineer of the Jura-Simplon Ry. Co. The chief reason given by the experts for their choice was the lack of empirical evidence supporting the various theories as to the exact action of combination iron and concrete arches under stress; it was considered doubtful if the extension of the metal tension members under stress would not rupture the concrete in which they were imbedded, considering the length of the span.

The arch construction adopted can be hardly better described than by the term articulated, there being a steel joint at each springing line and at the crown, designed to fix definitely the curve of pressure and to reduce the danger of fissures from expansion or settlement under load. This design was submitted by M. Bois, one of the competitors, and has a counterpart in the Munderkingen Bridge in Wurtemberg. Fig. 1 shows a side elevation and longitudinal section of the structure. The span of each of the large arches is 40 m. (131.2 ft.) and the rise is 5.55 m. (18.2 ft.). The total length of the bridge is 152 m. (498.56 ft.), the width of roadway 11 m. (36 ft.), the width of sidewalks 3.5 m. (11.48 ft.) each, and the width over all 20 m. (65.6 ft.). The left-hand arch crosses the main channel of the river which always flows full since it is separated from the other branch of the river by a wing dam, but in high water both channels flow full. The center and right-hand arches cross this right-hand channel, in which the flow varies from almost nothing to 2,000 c. m. per second. The 12 m. (39.36 ft.) arch at the extreme right spans the quay on the right bank of the river.

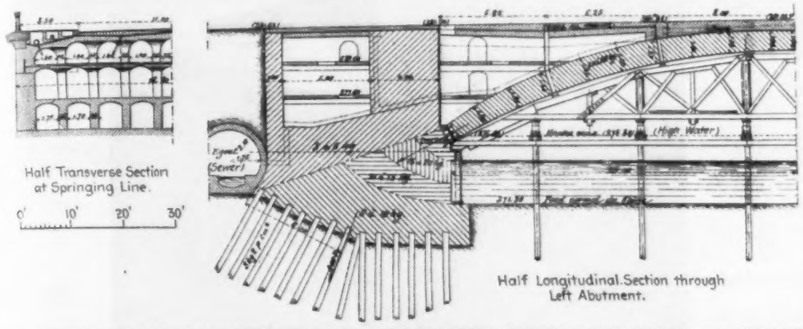


FIG. 2.—SECTION SHOWING LEFT ABUTMENT, ARCH AND SPANDREL CONSTRUCTION, COULOUVRENIERE BRIDGE.

With the exception of the left abutment, no great difficulties were encountered in any of the foundation work. This left abutment was on a bed of mud, and to render it safe against the weight a large number of piles had to be driven and capped with a thick mass of concrete. Fig. 2 shows the foundation as built and other features which will be noted further on. The character of the superstructure, of course, required unusual care to secure an unyielding foundation.

As has already been stated the main arches had spans of 40 m. (131.2 ft.) with three hinges or articulations each. Fig. 3 shows the character of the articulations and details of the abutment hinge. The crown hinge was exactly the same, but only 0.9 m. (2.95 ft.) deep. They were constructed entirely of steel and entirely buried in the concrete, except, of course, the bearing faces as shown. Each articulation or joint, running clear across the arch, required 60 frames of the character shown, or 30 concave and 30 convex bearings. Fig. 2 shows how each articulation is continued up through the spandrel filling.

To construct the arches centers were first built, as shown by Fig. 2. Upon these the concrete was laid in transverse, voussoir-like layers, Fig. 4, showing the method of work. Each voussoir was 1 m. (3.28 ft.) thick along the line of the intrados. Except that care was taken to even up the load on the centers by having voussoirs on the opposite haunches under construction simultaneously and to keep the centers carefully leveled, no exceptional precautions were taken. The composition of the concrete was 425 kg. (935 lbs.) of cement per 1 cu.m. (1.308 cu.yd.) of aggregate, which consisted of pebbles crushed to pass a hole of 3 cm. (1.18 in.) diameter. The concrete was mixed by machine. The placing of the concrete for the right-hand arch took 20 days and for the left-hand arch 10 days. The center for both arches was struck about 2½ months after their completion, the lowering being done gradually by letting the sand out of the boxes in which the posts rested. The settlement of the arches were as follows:

	Right Arch.	Left Arch.
Settlement upon striking center..	22 mm. (0.86 in.)	30 mm. (1.18 ins.)
Total settlement.	42 mm. (1.65 ins.)	38 mm. (1.49 ins.)

The character of the spandrel filling is shown clearly by Fig. 2, as is also the construction of the roadway and sidewalks. The sidewalk covers are plates of concrete with an embedded meshwork of iron. Various dimensions and details of construction not mentioned are shown by the illustrations. Exteriorly the bridge has the appearance of a stone structure of different kinds of stone, the piers being a yellow stone resting on granite, the spandrel walls white, the arch ring the natural concrete color, the cornice blue marble and the balustrade rose-colored granite. The construction was done by the city of Geneva, under the direction of its engineer, M. Butticaz.

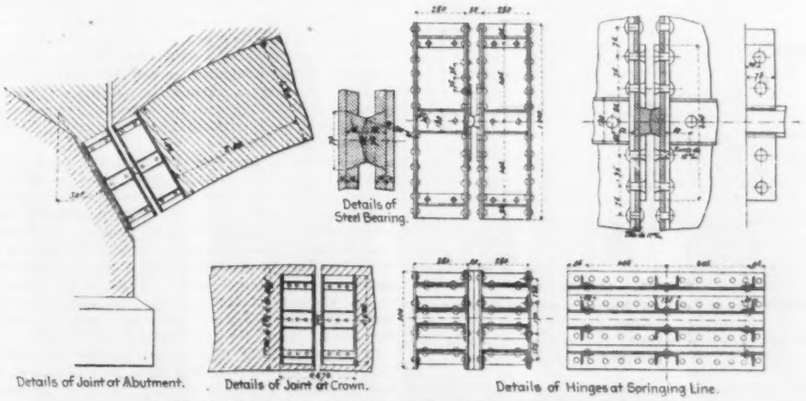


FIG. 3.—DETAILS OF ARCH HINGES, COULOUVRENIERE BRIDGE.

In its arch construction this bridge is a counterpart of the Munderkingen Bridge in Wurtemberg, which has a span of 50 m. (164 ft.) and a rise of 5 m. (16.4 ft.). Since the completion of the Coulouvreniere Bridge it has been subjected to some unusually heavy loads without exhibiting any deflection. The most notable of these loads were two locomotives weighing, together, 150 tons, which were taken across the structure one behind the other, and a test load of 500 kg. (1,100 lbs.) of gravel per square meter.

Fig. 4.—Diagram Showing Manner of Constructing Concrete Arch Ring, Coulouvreniere Bridge.

For the matter from which this description has been prepared we are indebted to our French contemporary, "Le Genie Civil."

PRELIMINARY REPORT OF THE COMMITTEE ON TESTS OF FIREPROOFING.

As most of our readers will remember, a series of tests of the resistance of structural materials to fire was arranged for several months ago, and the work was placed in the charge of an able committee consisting of Messrs. S. Albert Reed, representing the Tariff Association of New York; Geo. L. Heins, representing the Architectural League of New York, and Messrs. H. De B. Parsons and Thos. F. Rowland, Jr., representing the American Society of Mechanical Engineers.

This committee has just presented a preliminary report, showing the progress made to date in their work. The following is their report substantially in full:

Your committee, after having effected its own organization, determined to add to its numbers by the creation of an Advisory Board. This step was taken for the purpose of more widely increasing the interest taken in the experiments, and also to prevent, as far as possible, the impression that the work was of a sectional or local character. The names of the gentlemen who accepted invitations to serve on this Advisory Board, are as follows:

Edward Atkinson, President Boston Manufacturers' Mutual Fire Ins. Co.; Osborne Howes, Secretary Boston Board of Fire Underwriters; Charles A. Hexamer, Secretary Philadelphia Fire Underwriters' Association; H. H. Glidden, Manager Chicago Fire Underwriters' Association; W. Martin Aiken, Supervising Architect, U. S. Treasury Department, and Representative, Illinois Chapter, American Inst. of Architects; Stevenson Constable, Superintendent of Building Department, New York city; Geo. B. Post, New York Chapter, American Inst. of Architects; F. H. Kindl, Structural Engineer, Carnegie Steel Co.; John R. Freeman, Chief of Inspection Department Factory Mutual Ins. Co's; Henry Morton, President Stevens Institute of Technology; C. J. H. Woodbury, M. Am. Soc. C. E.; H. B. Dwight, Dwight Survey & Protection Bureau, New York; F. C. Moore, Delegate N. Y. Board of Fire Underwriters to Board of Examiners of Department of Buildings; Wm. A. Wahl, Secretary Franklin Institute, Philadelphia; John T. Williams.

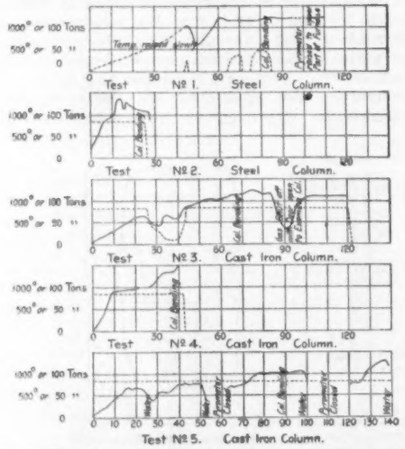


Fig. 2.—Results of Tests of Loaded Columns Exposed to Heat.
(Solid lines show temperature. Dotted lines show load on column.)

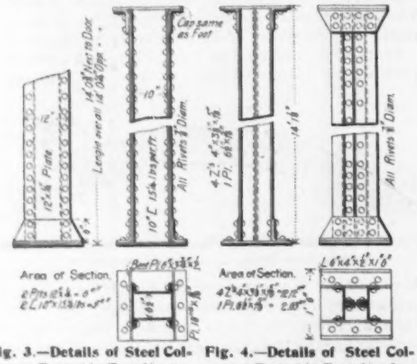


Fig. 3.—Details of Steel Column Tested in Test No. 1.

Fig. 4.—Details of Steel Column Tested in Test No. 2.

During the winter just past your committee erected a testing plant, as shown in the accompanying photograph (Fig. 1). The gas producer in the back ground is 9 ft. in diameter by 12 ft. in height, and is equipped with a hopper valve on top. Gas is generated by means of steam from the boiler as shown, and carried into the furnaces through pipes, as clearly indicated in Fig. 1. The foundation shown on the left is ready for the erection upon it of a furnace for testing beams and floors. It will be 27 ft. × 12 ft., but it can be arranged to take larger beams if so desired. The furnace shown on the right is for testing columns and is 14 ft. square, outside measurement.

The arched roof is made of fire brick and is independent of the side walls, being supported by outside corner posts. The walls are of common brick, but can easily be changed so that experiments can be made on other materials. One side wall and the end wall with the door, are 12½ ins. in thickness; the rear wall is 8½ ins. and the fourth wall is 4 ins. inside, 2 ins. air space and 8½ ins. outside, making a total thickness of 14½ ins. The floor is covered with fire brick, with openings left for the branch gas pipes and air spaces to support the combustion. These branch gas pipes are 4 ins. in diameter, capped with tuyeres reduced to 2 ins. In order to increase the temperature when desired, a barrel of naphtha is connected by means of a small pipe and blown into the gas pipe at the "Y" branch, by means of a steam jet.

The column is placed in compression by means of an hydraulic ram underneath, resting on three 24-in. I-beams, the same as those across the top of the furnace shown in the photograph. In order to keep the entire length of the column within the furnace, filler blocks of cast iron are placed between the ends of the column and these I-beams. The hydraulic ram is 12 ins. in diameter, and the water pressure can be carried to 2,500 lbs. per sq. in. The temperature is measured by means of a Uehling & Steinbart pyrometer (illustrated and described in Engineering News, Nov. 14, 1895).

The money to carry out this work has been advanced by various parties, and, together with the committee's disbursements, is shown in the accompanying treasurer's report.

(We omit the detailed report. It shows that $3,055 have been subscribed, chiefly by underwriters' associations, and $2,336.38 have been expended, of which about $2,000 was for constructing the apparatus shown in Fig. 1. The committee still owes $766.92, thus having spent to date about $30 more than the amount subscribed.—Ed.)

Your committee decided that it would be best to make the tests according to the following programme:

1. That a series of tests be made on columns of steel and of cast iron, without any fire protection whatever, these tests then to be taken as a basis of comparison with those that follow.
3. That a series of tests be made on unprotected beams and cast-iron columns, protected with different materials and in different ways.
3. That a series of tests be made on unprotected beams and girders.
4. That a series of tests be made on protected beams and girders.

It has also been proposed that each series be divided for test both with and without water.

Your committee has communicated with many manufacturers of fireproofing materials and has been informed that these manufacturers will submit their materials for purposes of tests.

Results of Tests of Unprotected Columns.

The result of this series of tests is shown in the accompanying diagram, Fig. 2, where the solid lines represent the temperature and the dotted lines the loads on the columns.

Test No. 1 was made on a steel column and the temperature was raised rapidly. Test No. 3 was made on a cast-iron column under similar conditions. Both columns began to fail as soon as they showed "red."

Test No. 2 was made on a steel column and the temperature was raised more slowly than in the other tests just described. Test No. 4 was made on a cast-iron column under similar conditions. Both these columns failed when they began to show "red," although the time was longer than in Tests Nos. 1 and 3.

Test No. 5 was made on a cast-iron column, and after heating a jet of water was thrown upon it through a ¾-in. nozzle. The column was first heated to 675° and then quenched with water without injury. The heat was then slowly raised again to 775° and the column again quenched with water. The heat was then raised slowly to a temperature of 1,075°, and the column, which then showed a "dull redness," was again quenched with water. The heat was then raised again to 1,300°, and the column, which now showed a "bright red," was again quenched with water. The column was beginning to yield by bending just before the last application of the water. The column was apparently unaffected by water, although it failed by bending under the load, the same as in Tests 3 and 4.

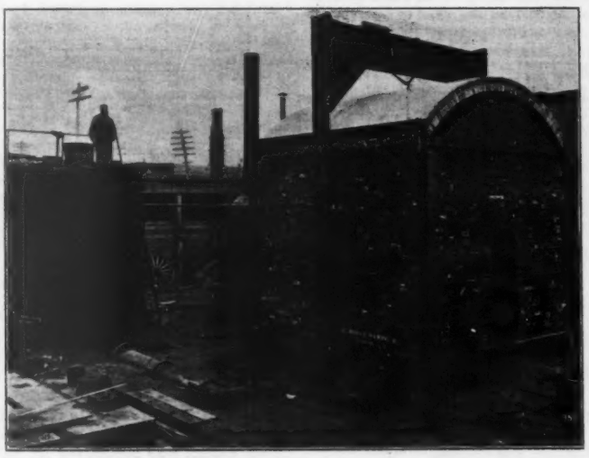


FIG. 1.—APPARATUS FOR TESTING THE EFFECT OF HEAT UPON STRUCTURAL MATERIALS.

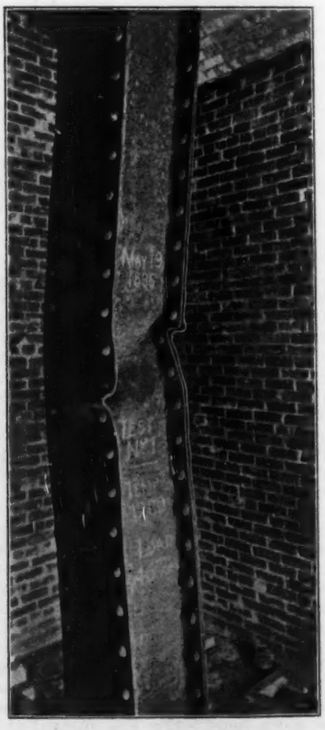


Fig. 5.—View of Column (Test No. 1) in the Furnace After Testing.

Detailed Log of Tests.

Column Test No. 1.—Fire Test without Water, Steel Column, May 19, 1896.

The walls of the furnace were of common brick, as already described, and the door was closed with a double thickness of sheet iron, which made the opening practically tight. The column was a Carnegie steel box channel, of the dimensions shown in Fig. 3 and was unprotected.

The gas producer was fired the day before, with valve closed against the furnace. The packing in the hydraulic cylinder leaked and a fitting of the pipe gave out as the test started. These causes delayed the use of the water pressure.

Log.

Time, h. m.	Pyrometer deg. F.	Hyd. pressure, tot'l l'd, tons.	Remarks.
10:35	.....	.....	Wood fire lit.
10:45	.....	.....	Gas turned into furnace.
11:02	.....	.....	Furnace door closed.
11:03	.....	.....	Naphtha valve slightly open.
11:13	.....	.....	Pyrometer put in furnace through lower hole, 2½ ft. abv. furnace door, with point 12 ins. from column.
11:19	1,025	.....	Pressure on column; light load.
11:20	1,050	.....	Pyrometer point 24 ins. from column.
11:25	600	.....	Raking gas producer; gas shut.
11:28	.....	.....	Gas turned on again.
11:33	1,025	.....	No naphtha.
11:36	1,225	.....	Half faucet of naphtha.
11:38	1,200	.....	
11:40	1,175	14.13	Water pressure on.
11:41	1,180	28.26	Quarter faucet of naphtha.
11:46	1,175	.....	Pressure off, water valve rep'k'd.
11:50	1,175	.....	Closed all air openings; water pressure on.
11:55	1,200	48.06	Column began to show "red."
11:56	1,210	.....	Column began to yield.
11:59	1,225	42.41	Hydraulic pressure falling fast.
12:10	1,230	.....	Pyrometer shut off; raised to upper hole, 8½ ft. above floor, and point 3 ft. from column.
12:16	1,230	.....	
12:25	1,250	.....	Gas shut off.

The column would have failed sooner if the working load of 80 tons could have been used. The result of the test is shown in the flashlight photograph (Fig. 5) taken of the column before it was disturbed. After the column was removed from the furnace Fig. 6 was taken. The brick walls of the furnace were cracked, the greatest damage taking place where one wall was bonded into the next and the cracks at these places extended through the bricks. Along the horizontal joints the walls cracked most on the bond courses. All the walls were hot, the 8-in. wall being too hot to hold the hand in contact with it.

Strength by Gordon's formula:

Breaking strength, per sq. in.....45,630 lbs.
Area of cross-section .....15 sq. ins.
Breaking load.....15 × 45,630 = 684,450 lbs. = 342 tons.

Actual greatest load, cold, 141.4 tons, with no change of form.

Column Test No. 2.—Fire Test without Water; Steel Column; Furnace Same as Test No. 1. May 27, 1896.

The column was a Carnegie steel Z-bar, as shown in Fig. 4, and was uncovered.

Log.

Time, h. m.	Pyrometer deg. F.	Hyd. pressure, tot'l l'd, tons.	Remarks.
2:23	80	.....	Pyrometer point 3 ft. from col.
2:24	200	84.8	Wood fire lit.
2:30	650	84.8	Gas turned on.
2:33	....	84.8	Door closed; full cock naphtha.
2:35	1,000	84.8	One-quarter cock of naphtha.
2:36	1,300	84.8	
2:37	1,350	84.8	
2:38	1,375	84.8	Naphtha closed.
2:39	1,300	84.8	
2:40	1,125	84.8	One-eighth cock of naphtha.
2:40½	1,300	84.8	
2:41	1,325	84.8	
2:42	1,250	84.8	
2:43	1,200	84.8	
2:44	1,175	84.8	Naph. cock closed to "dropping"
2:45	.....	84.8	Pyrometer moved to 2 ft. from column as flame touched point.
2:46	1,125	84.8	Column began to yield.
2:47	1,125	84.8	Column yielding fast.
2:49	1,100	84.8	Impossible maintain hyd. press.
2:51	1,100	84.8	Pump and gas stopped.
2:52	900	84.8	Pyrometer closed.
2:57	625	84.8	Gas shut off to poke producer.
2:59	500	84.8	
3:00	475	56.5	Removed loose bricks; interfered with tuyeres.
3:04	425	28.2	
3:05	450	.....	Gas truned on; door closed.
3:06	650	15.5	
3:08	667	.....	Air openings closed.
3:12	600	11.3	Door down to arrange bricks.
3:13	650	.....	Door closed.
3:13½	750	.....	Naphtha valve opened one-half.
3:14	750	.....	
3:15	812	42.4	
3:17	900	84.8	
3:21	950	84.8	
3:23	1,000	84.8	
3:25	1,025	84.8	
3:28	1,050	84.8	
3:30	1,025	84.8	
3:32	1,025	84.8	
3:36	1,100	84.8	
3:37	1,125	84.8	Slight redness reported by some.
3:40	1,137	84.8	Column reported bent slightly.
3:43	1,175	84.8	
3:44	1,200	84.8	
3:47	1,250	84.8	
3:50	1,225	84.8	
3:52	1,175	84.8	
3:55	1,200	84.8	Gas shut off; door down; column decidedly red and bent.
4:04	387	84.8	Gas on and door closed.
4:08	925	84.8	No naphtha.
4:09	925	84.8	Naphtha turned on one-half cock
4:10	1,000	84.8	
4:15	1,112	84.8	
4:32	1,125	84.8	Gas shut off; stopped pumping.

The result of this test is shown in the photograph, Fig. 7.

Strength by Gordon's formula:

Breaking strength, per sq. in.....42,820 lbs.
Area of cross-section .....14.15 sq. ins.
Breaking load..14.15 × 42,820 = 605,900 lbs. = 303 tons.

Column Test No. 3.—Fire Test without Water; Cast-iron Column; Furnace same as Tests 1 and 2. June 30, '96.

The column was a cast iron, hollow, round column, with flanges faced on both ends, as shown in Fig. 8, and was uncovered. It was cast horizontally, with a dry sand core, by the Cornell Iron Works, New York.

Log.

Time, h. m.	Pyrometer deg. F.	Hyd. pressure, tot'l l'd, tons.	Remarks.
2:32	.....	14.1	Wood fire lit.
2:45	.....	84.8	Gas lit, door being closed.
2:50	.....	84.8	Pyrometer in place, 18 ins. from column.
2:51	575	84.8	
2:54	625	84.8	

Strength by Gordon's formula was as follows:

Breaking strength .....902,000 lbs.
Safe load..... ....1-5 × 902,000 = 180,400 lbs. = 90.2 tons.

The result of test No. 3 is shown in the photograph, Fig. 8.

Column Test No. 4.—Fire Test without Water; Cast-iron Column; Furnace same as Tests 1, 2, and 3. July 6, 1896.

The column was a cast-iron, hollow, round column with flanges faced on both ends, and was uncovered. It was cast horizontally with a dry sand core, by the Cornell Iron Works, N. Y. The column had a length over all of 13 ft. ¼-in., thickness of flanges 1⅛ ins. flanges reinforced by four ribs, each ⅞-in. thick, reaching from outer end of flange to cylinder at an angle of about 45°.

Log.

Time, h. m.	Pyrometer deg. F.	Hyd. pressure, tot'l l'd, tons.	Remarks.
2:22	.....	.....	Wood fire lighted.
2:25	.....	84.8	Gas lighted.
2:28	.....	84.8	Pyrometer placed 18 ins. from column.
2:29	.....	84.8	Door closed.
2:30	675	84.8	
2:31	875	84.8	
2:33	900	84.8	
2:35	912	84.8	
2:40	950	84.8	
2:43	975	84.8	
2:44	1,000	84.8	
2:45	1,000	84.8	
2:49	1,000	84.8	Naphtha used, ¼ cock.
2:51	1,125	84.8	
2:52	1,100	84.8	More naphtha, ⅜ cock.
2:53	1,200	84.8	More gas.
2:54	1,300	90.1	
2:54½	1,325	84.8	
2:57	1,350	84.8	Column bending.
2:59	1,350	84.8	More naphtha, ½ cock.
3:01	1,375	84.8	Color reported.
3:03	1,500	84.8	
3:03½	1,525	84.8	Column yielding fast.
3:05	1,550	84.8	Column broke suddenly.

The result of the test is shown in the photograph, Fig. 9. The fracture occurred at about the center of the column where the deflection was the greatest. There was a crack about 5 ins. long, about 7 ins. above the fracture on the convex side of the column, showing that the column first pulled apart on the outside of the bend. No water was thrown on this column during the test.

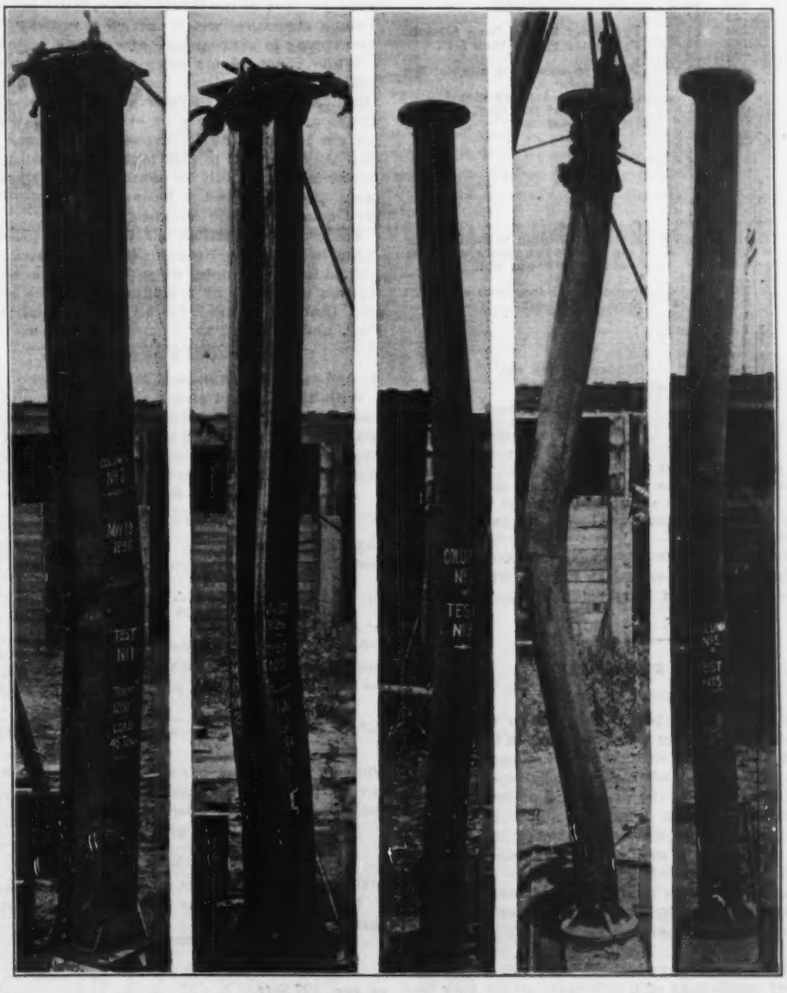


Fig. 6.—Steel Column, Load, 46 tons, Temp., 1,200°. Fig. 7.—Steel Column, Load, 84 tons, Temp., 1,100°. Fig. 8.—Cast-iron Column, Load, 84.8 tons, Temp., 1,100°. Fig. 9.—Cast-iron Column, Load, 84.8 tons, Temp., 1,850°. Fig. 10.—Cast-iron Column, Load, 84.8 tons. Temp., 1,300°.

FIGS. 6 TO 10.—VIEWS OF COLUMNS AFTER REMOVAL FROM THE FURNACE.

Column Test No. 5.—Fire Test with Water; Cast-iron Column; Furnace same as Tests 1, 2, 3 and 4. July 10, 1896.

The column was a cast-iron, hollow, round column, with flanges faced on both ends, and was uncovered. It was cast horizontally with a dry sand core, by the Cornell

Iron Works, N. Y. The column was 8 ins. in diameter, outside and 1 in. thick, the end flanges were 1⅝ ins. thick, and were reinforced with four ribs, as in test No. 4. There was a slight defect in this casting, there being a porous portion a few inches long on one side about 3 ft. 6 ins. from the lower end.

Water was thrown upon the column through about 50 ft. of 2½-in rubber hose, and a ¾-in. nozzle. The pressure at the hydrant was 50 lbs.

Log.

Time, h. m.	Pyrometer deg. F.	Hyd. pressure, tot'l l'd, tons.	Remarks.
2:16	.....	84.8	Wood fire lighted.
2:28	.....	84.8	Gas lighted.
2:29	600	84.8	Door closed; pyrometer in place 18 ins. from column.
2:31	625	84.8	
2:32	675	84.8	
2:33	700	84.8	
2:36	675	84.8	Pyrometer moved back 5 ft. from column.
2:40	625	84.8	
2:41	675	84.8	
2:42	525	84.8	Water thrown on column 1 min.
2:43	450	84.8	Door open; fire out.
2:44	400	84.8	Door open; fire relighted.
2:46	425	84.8	Door closed.
2:47	540	84.8	
2:49	1,000	84.8	Heat raising too fast.
2:51	650	84.8	
2:52	675	84.8	
2:55	700	84.8	
2:58	750	84.8	Pyrometer 3 ft. from column.
2:59	800	84.8	
3:01	740	84.8	
3:02	750	84.8	Pyrometer 18 ins. from column.
3:05	785	84.8	Pyrometer moved back 5 ft.
3:06	775	84.8	
3:09	400	84.8	Water on column ½ minute; fire out; door down.
3:16	.....	.....	Gas relighted; door closed.
3:19	675	84.8	Pyrometer 18 ins. from column.
3:22	700	84.8	More air admitted.
3:24	725	84.8	
3:27	775	84.8	
3:28	800	84.8	
3:30	900	84.8	
3:35	1,025	84.8	
3:40	1,025	84.8	
3:41	1,050	84.8	
3:50	1,050	84.8	Column red.
3:55	1,075	84.8	Water on column ½ minute; fire out; door down; more water on column as it was still red.
4:13	.....	84.8	Gas relighted.
4:17	750	84.8	Pyrometer 18 ins. from column.
4:21	787	84.8	Naphtha ½ cock.
4:23	900	84.8	
4:24	1,025	84.8	
4:27	1,150	84.8	
4:29	1,200	84.8	
4:30	1,250	84.8	Column getting red.
4:31	1,275	84.8	Column bending.
4:32	1,280	84.8	
4:34	1,300	84.8	Pyrometer moved back; water on column 1 minute.
4:35	.....	84.8	Door down and water on column again 2 minutes.

The result of this test is shown in Fig. 10. The column was very red when the water was thrown on it the last time. The brick walls and arch roof cracked when water fell on them. The column was badly bent, but otherwise appeared uninjured.

The report is signed by the Committee on Fireproofing Tests, whose names we give at the head of the article, and is dated at 22 William St., New York, July 27, 1896.

THE BRIDGE BRAKE.

By Robert Grimshaw.

The deflection of bridges or similar structures depends, other things being equal, upon their span. But the increase of deflection and change of form due to a moving load becomes less important, in a statical sense, as the proportion of live to dead load diminishes with increase of span. It is, however, far otherwise when we consider the oscillations caused by a moving load having impulses with a regular period, as for instance those due to marching troops or trotting horses; as such oscillations, when their rate harmonizes with that of the structure, increase successively in amplitude.

It has been demonstrated* that the period of vertical oscillations of a prismatic girder may be calculated from the deflections arising not only from its nearly-uniformly distributed dead and live loads, but from isolated loads. This is also the case with lateral vibrations, except that with these those deflections (other than those caused by wind and so-called centrifugal force) must be calculated on the supposition that the load acts in the same direction as the impulse. For example: With a cylindrical girder having the same moment of inertia in every direction transverse to its length, the vibration-period is the same in every direction, no matter what the direction of the impulses; as only the masses and their elasticity come into play, gravity being of influence only as regards the intensity of the impulses.

*Koepcke: "Deutsche Bauzeitung," pp. 163 of 1885 and 549 of 1886.

Besides the so-called centrifugal force, wind may cause lateral as well as vertical undulations—which in the case of the chains of Telford's Menai suspension bridge, increased so greatly that part of the carriageway got loose and hung down like an apron, to the water, 100 ft. below. To prevent a repetition of this occurrence, the two

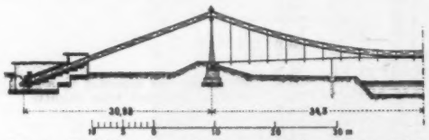


Fig. 1.—Half-Elevation of Suspension Foot-Bridge With Attachments for Preventing Oscillations.

chains, one above the other, on each side of the bridge, were connected by lattice-work.

The same manner of stiffening was applied on a railway bridge over the Danube Canal at Vienna, by Schnirch; but although it had served the desired purpose at the Menai bridge, it did not in the Vienna structure, which carried a railway track, and it was in consequence afterwards removed.

While short beams have such short vibration periods that impulsive moving loads can cause them no harm by successively-increasing vibration amplitude, girders of every kind, beyond a certain length, may be exposed (no matter how stiff they may be) to injurious vibrations by such influences as a body of marching men, keeping step; trotting horses, a locomotive having excessive counterbalance weights, etc.

The oscillation-period, in seconds, of a prismatic beam is stated by Koepcke (in the second paper quoted in the footnote) to be dependent on the deflection u_1 caused by a single load in the centre, and that u_2, caused by an equally-distributed load, and is equal to

$$t = \sqrt{0.0040252\ u_1 + 0.0031736\ u_2};$$

u_1 and u_2 being expressed in millimeters.

With an unloaded girder, only the deflection u_2, caused by the distributed dead load, comes into play; therefore the limit of resistance against vertical vibrations caused by a body of men keeping step at the rate of three paces per second, will be

$$u_2 = \frac{t^2}{0.003176} = \frac{0.3333^2}{0.003176} = 35 \text{ mm.}$$

say 1.38 ins., and if they march at only two paces per second, the deflection will be

$$u_2 = \frac{0.5^2}{0.003176} = 78.7 \text{ mm.},$$

or say 3.1 ins.

Supposing the coefficient of elasticity of a prismatic girder to be 2,000,000 kilos. per sq. cm. (= say 28,446,000 lbs. per sq. in.); the ratio of height to span $\frac{h}{l} = \frac{1}{10}$, and the greatest stress in the center 800 kilos. per sq. cm. (=say 11,378 lbs. per sq. in.); the expression for the extension and compression of the fibers

$$\delta = \frac{24 \times u_2 h}{5\ l^2} = \frac{24 u_2}{50\ l} = \frac{800}{2{,}000{,}000} =$$

0.0004; and as for men at a quickstep, u_2 is 35 mm. = 1.38 ins., we have the span l, corresponding to this step, as

$$l = \frac{24 \times 35 \text{ mm.}}{5 \times 0.0004 \times 10 \times 1000} = 42 \text{ meters,}$$

or say 137.8 ft.

For men marching at two paces per second, the deflection of a beam undulating in half-second periods being 78.7 mm. = 3.1 ins., we have the minimum span of such a beam

$$l = \frac{24 \times 78.7}{5 \times 0.0004 \times 10 \times 1000} = 94.4 \text{ meters,}$$

or say 309.7 ft.*

*When we notice that the deflection for 3 steps and 2 steps per second are 1.38 and 3.1 ins. respectively, and the spans corresponding to those rates of undulation are practically 138 and 310 ft. respectively, we have a ready rule (which I believe I am the first to point out) for getting the span from the deflection; the span in feet is 100 times the deflection in inches; and the span in meters is 12 times the deflection in centimeters.

As these quantities, 42 and 94.4 meters, or 137.8 and 309.7 ft. respectively, are small, the vibrations of common iron girders would occur oftener if the passive resistances of sliding or of rolling friction on the piers did not consume the "vis viva" of marching men, etc. This sliding or rolling is due to the lengthening of the lower flange of the girder under tension, which necessitates that one end or both shall slide on the bed-plates. In many cases such frictional resistance is sufficient to prevent increasing deflection under repeated impulses, regular in time and amount, such as those due to marching troops.

The absence of such friction on the bed-plates causes girders in the form of double arches symmetrical to a horizontal axis, such as those over the Rhine at Mayence (by Pauli), over the Elbe at Hamburg (by Lenz), or the Tamar at Saltash (by Brunel) to be more subject than straight girders to vertical vibrations.

As the vibration-period, and the danger, decreased with the diminution of the real or possible deflections by dead and live loads, so continuous girders are less subject to vibrations than are those covering only one span, or which, like those of the Gerbex type, are sectional; and still less so than all arch and suspension bridges.

The counteracting of the creation of oscillations or the shortening of their periods, may be effected.

(1) By strengthening the structure; or

(2) By the addition of special parts, acting like the finger of a violin-player in generating overtones; or

(3) By frictional devices.

The following examples are cited by Koepcke:

(1) The suspension foot-bridge shown in Fig. 1 was liable to strong oscillations by the passage of even a few men keeping step. This was stopped by a contrivance which was used in some other and similar instances for a similar reason; a friction brake.*

Although the chains of each pair on each side were bound together by lattice-work, this stiffening was not sufficient, as the span was 69 meters = 226.4 ft.; and the more so as the links of the chain had a cross-section of but 100 × 8 mm. =

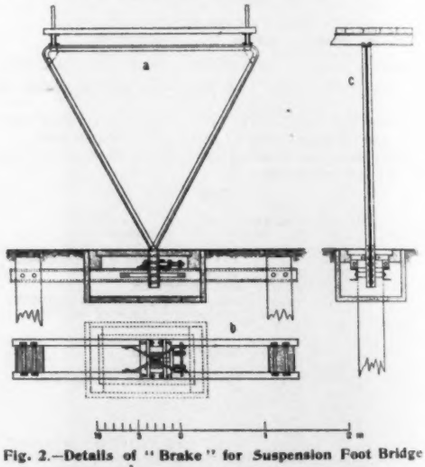


Fig. 2.—Details of "Brake" for Suspension Foot Bridge

3.937 × 0.315 ins., and as the wooden floor was light. The chain was easily deformed by unsymmetrical loads; and as the bridge had a width of only 2.3 meters = 7.55 ft., it rocked like a boat by reason of the deformations of the two sides being different.

In this case there were attached to the bridge, at the center and at a point 15 m. (49.2 ft.) therefrom, two devices shown in Fig. 2; each consisting of a triangular frame fastened under the footway, and having at its lower end a vertical continuation sliding in a clamp, which latter was placed below on the river-bank and acted on by springs, the tension of which was regulated by screws. The springs caused a frictional resistance of about 500 kilos. = 1,100 lbs., which was sufficient to resist the oscillations caused by troops passing over the bridge. The frames help, by their stiffness, to prevent rocking, and to keep

*See "Deutsche Bauzeitung," as before cited.

the brake-poles vertical and their upper frames horizontal.

The supports on brakes may readily be raised in case of high water to prevent damage by floating ice, or drift—and as their resistance is but slight (say 500 kilos. = 1,100 lbs. each) the stresses in the main members of the bridge, and the motions due to temperature-changes and load-variations, are not materially affected.

This device proved efficient, and is still in place and effective.

In the case of the famous Loschwitz-Blasewitz rigid-suspension bridge over the Elbe, above Dresden, there are applied brakes at the center, to join the ends of the stiffening-girders. As the suspension girders require free movement about the hinges at the water, only a yielding connection, operating by friction, is here admissible. This connection is simply but perfectly effected by clamping an iron plate 20 mm. (0.787 in.) thick between two others, each 15 mm. (0.59 in.) thick, the compression being effected by nine screws

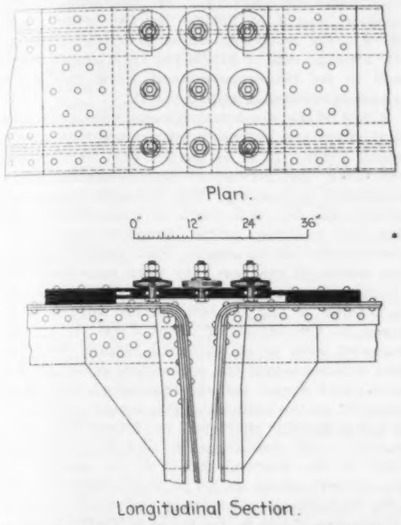


Fig. 3.—Plan and Sectional Elevation of "Brake" at Junction of Stiffening Girders of the Loschwitz-Blasewitz Suspension Bridge, Dresden.

each 35 mm. (1.15 in.) in diameter, held in constant tension by a pair of Belleville-steel spring washers. (See Fig. 3.) The clamped plate has slots cut lengthwise in it, long enough to permit the greatest changes of position caused by extremes of temperature and of load. The stresses in the screws being calculated at about 1,000 kilos. per sq. cm. (14,223 lbs. per sq. in.), and the coefficient of friction being 0.2, this would show a resistance of

$$\frac{2 \times 3.5^2 \times 3.14 \times 9 \times 1000 \times 0.2}{4} = 34{,}650$$

kilos., or say 76,403 lbs. As this resistance is applied at a point 2½ meters above the hinge, the moment of resistance is $2.5 \times 34650 = 86.6$ ton-meters, or say 281 English foot-tons on either side of the bridge; representing a very considerable capacity of resistance against oscillation from marching men, trotting horses, etc.

The sliding friction of about 35 meters = 34.45 long English tons, being but slight in comparison with the stresses on the hinges, which range between 579 and 826 metric tons (= say 570 and 814 gross tons); and being slight even compared with the strength of the compression-member of the stiffening-girder, which member has a cross-section of $1.5 \times 87 \times 4 \times 10 \times 1 = 210$ sq. cm. = 32.55 sq. ins., it is therefore not harmful.

A similar contrivance has been applied in this same bridge to the studs of the tension-members of the side-girders, which move in holes in the pillars. Each stud being clamped by two screws, the sliding friction is, under the same assumption as before,

$$\frac{2 \times 2 \times 3.5^2 \times 3.14 \times 1000 \times 0.2}{4} = 7{,}693$$

kilos., or say 16,955 lbs.

Here the distance from the fulcrum or pillar-head being 25 meters = 82 ft., the moment of resistance is $25 \times 7.693 = 192.3$ ton-meters = say 362 foot-tons.

The bridge brake is applicable to almost every other form of bridge construction. In rope and chain suspension-bridges of the ordinary type, the oblique stays between the points of suspension and the roadway frames should not be bolted or riveted to the latter, but fastened by stirrups. In some cases the above-described method adopted at the Loschwitz bridge, will be feasible; either vertical or inclined supports being used.

Bracing such as that of the Lambeth bridge over the Thames at London, which acts by friction, as for instance in the center and at the pillars, will prevent or lessen oscillation without perceptibly affecting the necessary movability.

The bridge brake is also applicable to girder bridges. The ends of girders on the pillars may be connected by the same contrivance as is used at Loschwitz, in the center.

The device is especially suitable to cantilever girders, for making the connections between sections, and thus preventing both horizontal and vertical undulations.

STREET RAILWAY STATISTICS OF THE UNITED STATES.

We are indebted to our contemporary, "The Street Railway Journal," for the accompanying table showing the mileage, rolling stock and capitalization of the street railways of the United States. The figures in the table were compiled from returns from the various street railway companies collected by our contemporary for its financial supplement: "American Street Railway Investments," which was reviewed in our issue of July 30.

The caution is given that the above figures are to some extent approximate, there being a certain percentage of companies which refuse to give information. Our contemporary estimates that figures for capital stock and funded debt are in error not more than 7% in any state, and in most of the states not more than 3 or 4%. Its statistics for mileage and cars do not differ from the correct figures more than 3 or 4% in any one state. While these statistics are published in the August number of our contemporary, it will be understood, of course, that the time necessary to collect and compile returns is such that the statistics actually represent the conditions of some months ago. Probably it would be not far from right to say that they represent the condition of street railway properties at the beginning of 1896.

It will be seen that about six-sevenths of the total mileage is equipped with electric traction. About 1,200 miles of horse-car roads and 600 miles each of dummy and cable roads make up the balance. The enormous capitalization of the roads in the Middle States, averaging $147,300 per mile, suggests the idea that capitalization is based on earning power rather than on the actual cost of the roads.

STATISTICS OF THE STREET RAILWAYS OF THE UNITED STATES.

STATES.	No. of Roads.	HORSE. Miles.	HORSE. Cars.	ELECTRIC. Miles.	ELECTRIC. Motor Cars.	ELECTRIC. Trail. Cars.	CABLE. Miles.	CABLE. Grip Cars.	CABLE. Trail. Cars.	MISCELLANEOUS. Miles.	MISCELLANEOUS. Dummy Engines.	MISCELLANEOUS. Coaches.	TOTAL. Miles.	TOTAL. Cars.	CAPITAL STOCK. Total.	CAPITAL STOCK. Per Mile Track.	FUNDED DEBT. Total.	FUNDED DEBT. Per Mile Track.	CAPITAL LIABILITIES. Total.	CAPITAL LIABILITIES. Per Mile Track.
New England.																				
Maine	13	17	34	96	165	64							113	263	1,977,875	17,200	2,253,000	19,600	4,230,875	36,800
New Hampshire	8	14	36	56	80	35							58	153	373,500	7,200	330,000	20,600	703,500	17,900
Vermont	5			29	37	9							29	46	472,000	16,300	400,000	13,800	872,000	30,100
Massachusetts	87	54	692	1,095	3,445	540					6	9	1,155	4,186	37,114,000	32,200	23,000,000	20,000	60,114,000	52,300
Rhode Island	8	3	8	137	370	219							140	597	6,330,000	59,600	8,157,000	59,700	15,072,800	119,100
Connecticut	23		21	334	702	300							334	983	8,646,740	26,900	6,970,000	20,900	16,321,740	48,900
TOTAL	153	88	782	1,779	4,808	760				6	9		1,895	6,564	57,914,115	31,600	41,438,500	22,700	99,352,615	54,600
Eastern States.																				
New York	209	298	2,058	1,382	4,550	680	55	820	201	172	493	1,371	1,909	10,381	174,374,184	91,600	173,993,596	91,200	347,967,737	182,800
New Jersey	36	40	200	343	1,200	132	2						586	1,529	35,015,830	59,900	33,627,000	57,700	68,642,830	117,600
Pennsylvania	126	96	774	1,451	5,715	870	87	756			3	4	1,691	6,796	134,860,445	80,000	72,067,888	42,600	206,930,333	122,600
Delaware	6			27	63								27	63	479,000	15,500	600,000	22,200	1,079,000	37,700
District of Columbia	10	83	369	59	200	171	18	147	173				140	877	14,400,300	108,800	6,300,000	51,100	19,170,300	137,000
Maryland	6		109	233	660	98	38	138	60				271	907	12,815,150	47,700	12,963,000	48,300	25,811,150	96,000
Virginia	17	101	87	103	247	39				4	1	4	177	348	5,600,230	32,600	4,800,000	27,100	10,400,230	58,700
West Virginia	4	6	7	18	32	6				4		8	41	84	1,340,000	32,200	620,000	14,600	1,960,000	47,800
TOTAL	396	414	3,655	3,884	10,581	1,373	198	1,853	436	188	498	1,599	4,634	18,396	379,168,136	81,800	305,633,184	65,900	680,001,580	146,700
Central States.																				
Michigan	31	3	3	438	1,009	222				9	6	7	450	1,240	9,137,500	20,300	7,344,500	16,300	16,381,400	36,400
Ohio	60	52	81	1,013	2,480	954	44	354	105	3	7		1,132	3,339	57,146,800	50,400	26,033,500	22,900	83,180,300	73,300
Indiana	39	23	46	505	978	156							528	1,134	10,776,530	20,400	8,617,000	16,300	18,987,530	35,900
Kentucky	16	48	139	167	290	207							211	629	7,465,000	35,300	6,585,000	31,100	14,050,300	66,300
Wisconsin	16	4	5	371	336	137							371	477	6,830,000	34,600	5,344,000	27,800	12,174,000	62,400
Illinois	48	72	497	877	1,746	2,040	82	617	339	37	78	305	1,060	6,265	76,430,305	74,000	64,109,650	62,300	140,557,955	134,300
Minnesota	11	7	11	279	667	338	7	40					298	1,056	19,714,000	65,800	14,113,000	48,400	33,827,000	115,600
Iowa	24	13	19	210	278	140	7	14	20	5			237	474	8,786,000	37,000	4,268,000	18,000	13,054,000	55,100
Missouri	31	31	62	494	963	696	101	320	492				629	2,537	29,375,300	46,700	29,161,000	47,900	58,536,300	94,600
TOTAL	279	226	783	4,105	7,881	5,577	241	1,311	948	44	91	312	4,600	16,737	229,862,735	49,900	166,914,650	36,200	396,777,485	86,600
Southern States.																				
North Carolina	8	8	5	38	61	9				1	2		43	76	611,000	14,200	720,000	16,800	1,331,000	30,700
South Carolina	6	36	65	10	6	4							46	73	460,000	10,000	193,000	4,200	653,000	14,200
Georgia	23	15	21	229	311	70				9	9	2	249	413	6,436,400	17,800	4,598,500	20,000	9,404,900	37,800
Florida	7	12	13	27	23	6				2	2		29	38	536,500	6,900	611,000	7,800	147,100	7,000
Alabama	15	18	23	76	98	33				103	83		194	286	8,617,200	29,000	6,475,000	16,700	8,092,800	41,300
Mississippi	5	12	23	4	4					6	2	12	22	18	295,000	9,300	16,500	900	311,500	10,200
Tennessee	19	26	21	82	207	48	4			7	3	4	93	267	3,772,500	24,700	3,887,600	16,600	9,661,100	41,300
Louisiana	11	28	54	156	427	4				8	7	6	164	441	11,665,700	65,300	5,029,400	29,100	20,695,100	118,300
Arkansas	9	34	70	31	61	16				1	1	4	32	170	1,330,375	19,900	373,700	10,000	1,704,075	29,900
TOTAL	93	164	399	793	1,198	273	4	8		138	84	168	1,096	2,205	30,580,675	27,900	22,038,300	20,100	52,600,575	48,000
Western States.																				
North Dakota	4	6	7	11	5	6							77	14	350,000	20,600	75,000	4,400	425,000	25,000
Nebraska	12	26	30	180	260	231							93	456	8,437,500	39,600	4,420,000	20,800	12,857,500	60,400
Kansas	18	18	30	102	151	77				11	5	14	113	270	3,669,000	27,000	2,618,000	19,400	6,312,000	46,400
Texas	32	72	149	254	304	40	4	1		11	4	15	301	330	6,335,500	18,900	3,380,600	15,400	11,716,100	33,900
Colorado	16	7	5	288	256	104	30	70	78	28	4	20	362	483	10,355,000	26,800	9,109,000	23,500	19,464,000	74,100
Montana	3			47	34					7			54	87	1,700,000	34,700	1,830,000	37,300	3,530,000	72,000
Idaho	1			4	2								4	2	54,000	13,500			54,000	13,500
Utah	2			50	80	17				6	2		56	102	1,436,000	14,800	1,000,000	10,600	2,436,000	25,600
Washington	22	4	6	210	135	37	18	45	13				250	324	9,202,000	42,300	6,074,457	28,200	15,276,457	68,500
Oregon	10	5	4	105	85	14	3	18		24	13	29	137	230	2,664,500	19,600	2,320,000	16,900	4,984,500	36,500
California	47	200	409	401	327	67	152	718	70	67	72	43	620	1,317	42,356,900	51,700	22,088,000	26,000	64,444,900	77,600
TOTAL	157	343	650	1,622	1,636	344	207	854	164	143	106	110	2,317	4,562	87,136,400	37,600	56,552,057	23,500	141,748,457	61,100
United States.	916	1,219	5,582	12,133	26,240	8,799	886	5,309	1,840	510	760	2,198	14,470	48,118	784,813,780	54,200	590,536,391	40,800	1,375,470,171	95,000
Canada.	30	13	37	430	714	436							480	1,180	17,517,300	37,000	5,685,000	12,300	23,182,300	50,200

The catalogue of Purdue University at Lafayette, Ind., shows a total of 635 students in attendance during the year just closed. The class just graduated numbered 108. The University's famous locomotive testing plant has made it widely known in railway circles, and if the Master Mechanics' Association had its scholarship endowment fund to dispose of over again there is no doubt that Purdue would be the institution selected.

The commencement announcement of La Fayette College, Easton, Pa., shows a graduating class numbering 50 members, of whom 20 received degrees in technical courses; 8 as civil engineers, 2 as mining engineers, 6 as electrical engineers and 4 received the degree of B. S. in chemistry.

University of Virginia, Charlottesville, Va.—The technical department of this institution is small, and out of 518 students attending the university the past year, only 14 were studying engineering. The university has a picturesque and healthful location among the foot-hills of the Blue Ridge mountains in the central northern part of the state. On Oct. 27, 1895, a fire destroyed the central building, known as the Rotunda. By this fire a large portion of the library was lost, but it is being rapidly restored, by contributions from indi-

viduals and other institutions of learning. The Virginia legislature has recently passed a bill through which it is expected that $200,000 will be realized for restoring the burned building.

Summer courses in law, chemistry and engineering are given, lasting eight weeks. The tuition fees are $50, $50 and $45, respectively.

The Leland Stanford Junior University, at Palo Alto, Cal., had, during the past year, 163 students in civil engineering, 125 in mechanical engineering and 85 in electrical engineering; the total number of students in the university being 1,069, 378 of whom were women. The total number of professors and instructors is 106. A summer school offers instruction in nearly all departments; the tuition is from $5 to $35. Tuition in the university proper is free.

The University of Minnesota, at Minneapolis, had an attendance during the past year in all departments of 2,467. The engineering department includes courses in civil, electrical, mechanical and mining engineering, also in metallurgy and chemistry. The requirements for admission are the same in all these courses, and include in mathematics only geometry and higher algebra. Shop work is required in none but the mechanical course; here it extends to the senior year, a total of 836 hours being required, which is an average of eight hours per week throughout the three years. The catalogue for 1897 contains 280 pages; a glance at the addresses of the students shows that a very large number are from Minneapolis.

Worcester Polytechnic Institute, Worcester, Mass. —President T. C. Mendenhall requests us to state that, by recent enactment of the state legislature, 20 new free scholarships become available to the next entering class. This makes 40 free scholarships in all available, being one for every senatorial district in the state, in addition to the 25 or 30 free scholarships to which students from Worcester county only are eligible.

University of Arizona, Tucson, Arizona.—This institution was opened in 1891; it has one main building, 105 × 200 ft., two stories high, a mining annex, 80 × 60 ft., and a number of small dormitories. It is situated about a mile from Tucson, on a 40-acre tract of land surrounded by attractive mountain scenery. Owing to the dryness of the climate and freedom from sudden changes this section has become quite a noted health resort. Tucson is 500 miles east of Los Angeles, at an elevation above sea level of 2,400 ft.

In engineering, the courses offered are civil, mechanical, electrical, mining and metallurgy, all leading to the degree of B. S. The whole number of students attending the university during the past year was 99.

Case School of Applied Science, Cleveland, O.—This school was founded in 1877 by Leonard Case and during the ten years in which Prof. Cady Staley has been its president the attendance has increased from 44 to 229. The mathematics required for admission are geometry and elementary algebra. Shop work, including joinery, pattern making and iron work, is required of all students in mechanical, electrical and mining engineering.

During six weeks of the summer vacation the laboratories will be open and instruction will be given in mathematics, chemistry and shop work. The catalogue contains a list of all the graduates which shows the majority to be holding excellent positions. Accompanying the catalogue is a separate pamphlet containing the president's annual report. It sets forth the progress of the school and devotes considerable space to rules for the government of athletics.

Agricultural and Mechanical College of Texas, College Station, Tex.—The twentieth annual catalogue contains 108 pages and 33 full page illustrations relative to the university and its special features. Arithmetic, English and History, constitute the reuqirements to enter the freshman class. These are four courses: Agriculture, horticulture, mechanical and civil engineering. The total number of students in attendance during the past year was 354.

IRON MINING on the Gobebic range has nearly ceased. The Tilden mine closed on July 31. It is stated that only 1,000 men are now working on the range where 8,000 are employed in busy times.

TRANSMISSION OF ELECTRICITY FROM NIAGARA FALLS TO BUFFALO.

For months past the press has contained numerous articles relative to the possibilities of the electricity generated at Niagara Falls. In fancy it has been transmitted to Chicago and New York, to there carry on all the various operations to which electricity can be applied. During this time, however, right of way has been secured for a transmission line between Niagara Falls and Buffalo. The construction of this line is alone estimated to cost $500,000. The poles will be of cedar and from 35 to 50 ft. long. The conductors will be of bare copper wire of 350,000 circular mills. We print a short description of the system.

The first step towards the actual transmission of the power of Niagara Falls over any considerable distance has been made, and Buffalo will be the first city to benefit by it. By Nov. 4 next, the cars of the Buffalo Ry. Co. will be driven by the electricity generated at the power house by the side of the great cataract, and the transmission of its power over a long distance will have become an accomplished fact.

Contrary to expectations, the system of transmission employed is not the two-phase, but the three-phase system, developed by the engineers of the General Electric Co., the advantage in favor of the latter lying in the fact that the transmission can be effected over three wires, whereas, in the two-phase, four wires must be used to convey the same amount of power. Thus the cost of the fourth wire is saved by the use of the three-phase system.

The contracts were made between the Cataract Construction Co., supplying the electricity, and the General Electric Co.; and between the latter company and the Buffalo Power & Conduit Co. controlling the supply and distribution of the Niagara power in Buffalo, and the Buffalo Ry. Co. The contracts provide for all the apparatus and machinery necessary for the transformation of, transmission, conversion and delivery of 1,000 HP. to the overhead wires of the Buffalo St. Ry. system.

The contract with the Cataract Construction Co. covers three of the air blast type transformers. These will be the largest transformers ever constructed, and will step-up the Niagara 2,200-volt two-phase current to either 11,000 or 22,000 volts three-phase. Any two of the transformers together will deliver 2,500 HP.; the third is a spare one. It is the intention of the Cataract Construction Co. to commence transmission operations at 11,000 volts, and later to increase the capacity of their transmission system by increasing the potential to 22,000 volts. The transformers will be designed and insulated to withstand the latter pressure. A complete system of air blast apparatus is also to be provided for cooling these transformers, as well as a marble switchboard with all necessary instruments for controlling their operation.

The pole line will be erected by the White-Crosby Co., and will have capacity sufficient to transmit 40,000 HP. This line will run from the transformer house at Niagara Falls along the two-mile line road near the track of the New York Central and Erie railways, will cross the creek at Division street, and from Tonawanda to the Buffalo city line will follow the canal banks.

For transforming the power down and converting it into that suitable for street railway purposes, the Power & Conduit Co. has purchased four static transformers of about 360 HP. each, and two 500 HP. rotary converters. The transformers will reduce from the line potential of either 11,000 or 22,000 volts to 400 volts, at which voltage the three-phase current will be turned into the rotary converters, and then converted into direct railway current of 550 volts. These transformers and converters will be set up in the Niagara street power station. The latter will be compound wound, and will operate in multiple with the steam-driven generators supplying the balance of the power necessary for the operation of the railway system. They will be of iron-clad type with steel frames, with collector rings for the three-phase current at one end, and a commutator for the direct current at the other. They will have six poles and will run at 500 revs. per minute, and are similar to that placed in the Niagara power house to furnish current to the Buffalo & Niagara Falls R. R.

Work will be begun at once and current will be transmitted from Niagara to Buffalo before winter sets in. It cannot be doubted that this is but the first step to a much larger use in Buffalo of the power of Niagara Falls, and that having once begun to deliver power into that city, the Niagara Power Co. will find a large demand for its output.

THE NEW U. S. LOCK AT SAULT STE. MARIE was informally opened for the first time at 10 a. m., Aug. 3. The first vessels to enter were the government boats "Hancock," "Andy Johnson," and "Antelope." The intermediate and upper lock gates only were used. Press dispatches state that the chamber was filled in about 13 minutes, not all the valves being opened at first, and it was emptied in 8 minutes. The gate machinery worked well, the lower gates closing in 3 minutes.

RENEWALS OF TIMBER RAILWAY BRIDGES WITH PERMANENT STRUCTURES.

In the report of the characteristics of the Lake Erie & Western R. R., made by Mr. W. F. Goltra, C. E. (Chief Clerk to the Chief Engineer), and representing the condition of the road on Jan. 1, 1896,* there is an interesting statement regarding the gradual substitution of wooden structures with permanent work composed of iron, steel or stone and filling with earth, for wooden structures.

On Jan. 1, 1887, there were 66,243 lin. ft. of bridges, all of which were wooden structures, with the exception of 523 ft. The permanent work then consisted of two iron girders, a few stone arches and stone boxes, 34 cast-iron pipes and 146 terra-cotta pipes. Since the present management took charge, on Feb. 1, 1887, permanent improvements have been made, gradually reducing the length of wooden structures from 65,720 to 31,037 ft., and permanent work has been substituted to the extent of 34,683.7 ft.; including 9,510.3 ft. of iron, steel or stone structures, and 25,173.4 ft. of solid earth embankment, thus shortening the aggregate length of bridges to the latter extent. Most of the costly structures have been built, and the average rate of $18.96 per ft. is higher than it will be for future permanent work, the cost of which is estimated at $15 per ft.

A few of the wooden structures were built in recent years and will not need renewal before six or seven years. It is estimated that the work of executing the permanent improvements will be completed by January, 1903, but as the annual appropriation for this work is dependent on the financial condition of the company, and also on the number of structures that require renewal, the estimated progress may vary somewhat. The estimated cost of completing the permanent structures is $420,000,000. Some wooden structures, to the extent of about 3,000 ft., may be renewed with wood owing to certain conditions that will not admit the economical substitution of permanent works, and the renewal of these is not included in the estimate. The length of bridging is being rapidly shortened by filling with earth, making solid embankments, and it is estimated that of the original 66,243 ft. of bridging on Jan. 1, 1887, about 45,000 ft. will be replaced with solid embankment, reducing the total length of bridging to 21,243 ft. by January, 1903.

Where iron pipe-culverts, stone arches and boxes can be used, and the depth does not exceed 15 ft., the cost of permanent work is but little more than that of renewing wooden trestles, and seldom exceeds twice the cost, including the cost of filling openings with earth. For larger openings, where plate girders and masonry are necessary, the cost is little more than twice and seldom exceeds three times the cost of renewing wooden structures. The average life of wooden structures on this road is nine years. The cost of wooden trestles, not exceeding 15 ft. in height, is $7 per ft.; and that of wooden truss bridges is $28 per ft. Taking all the wooden structures into consideration, the average cost to renew them would have averaged about $9.90 per ft., while the permanent improvements will cost, when completed, an average of about $17.20 per ft.

Mr. Goltra says that if we view the question of cost from a financial standpoint only, and assume the interest at 5% on the investment for permanent improvements, the life of wooden structures at nine years, and average cost of same at $9.90 per ft., it is easy to calculate that it would be profitable to spend $3 for permanent work rather than to spend $1 for renewal of wooden structures, and as the ratio of cost for renewal of wooden structures and permanent work will only be about as one to two, the saving by making permanent work is apparent. But aside from this, what is saved by the reduction of openings in the track, thereby eliminating danger by fires, wrecks and accidents, is incalculable. The conclusion is, that if there is money available to make a roadway of permanent character at the earliest possible moment, it is certainly an element of economy in the operation of a railway to carry out such work as rapidly as possible.

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*The first "characteristic" report made by Mr. Goltra was reviewed at some length in our issue of April 25, 1895.